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Biographical notices of mineralogists recently deceased. (Fifth series.) [1]

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[Read March 23, 1933.]

IN the following list of 41 lives, with a range in ages from 45 to 94 years, the average age is 70·7 years. Including previous lists, the average of 424 lives is 65·4 years. As shown in the following table there has been a gradual increase in this average during past years.

Series.	Period.	Min. Mag. vol.	No. of lives.	Total years lived.	Average age.
—	1876–1919	1–18	210	13,271	63·2
I.	1919–21	19	43	2,738	63·6
II.	1921–24	20	49	3,317	67·7
III.	1924–27	21	42	2,858	68·0
IV.	1927–30	22	39	2,660	68·2
V.	1930–33	23	41	2,899	70·7
			424	27,743	av. 65·4

Acheson (Edward Goodrich) [1856–1931], discoverer and manufacturer of carborundum (SiC), which he first made accidentally in 1891 when experimenting with the electric furnace in the hope of producing diamond artificially. He also produced siloxicon (Si_2C_2O)

[1] Series I–IV in Min. Mag., 1921–30, vols. 19–22. An index to earlier notices in vols. 1–18 is given in vol. 19, pp. 259–262. A mortality curve is given in vol. 20, p. 253.

and artificial graphite on a large scale at the Niagara Falls. He was born at Washington, Pennsylvania, on March 9, 1856, and died on July 6, 1931.

Andrews (William Symes) [1847–1929], electrical engineer, was born on September 10, 1847, at Saltford near Bath in Somersetshire, and died on July 1, 1929, at Schenectady in New York State. He went to America in 1875 and in 1879 entered the service of Thomas Alva Edison [1847–1931]. From 1894 he was in the employ of the General Electric Company at Schenectady. There as a result of his work on the improvement of X-ray tubes he lost his hearing and sight. He was also interested in fluorescence and phosphorescence, and in the problem of 'cold lighting'; and in this connexion he prepared various fluorescent artificial minerals [M.A. **2**–22]. He was instrumental in introducing at the zinc mines at Franklin Furnace, New Jersey, the use of the iron-spark, rich in ultra-violet rays, for detecting the presence of willemite in the waste tailings from the concentration plant. (C. Palache, Amer. Min., 1932, vol. 17, pp. 78–79.)

Azéma (Léon) [1852–1931], a Lieutenant-Colonel in the French Army, joined the French Mineralogical Society in 1909 and was its President in 1921. As a volunteer he had worked for many years in the mineralogical collections in the Natural History Museum in Paris, and under the name of 'Colonel Azéma' he wrote since 1906 a few papers on minerals and rocks. He compiled the useful and detailed geographical index which forms the bulk of vol. 5 of A. Lacroix's 'Minéralogie de la France et de ses colonies'. He died on June 9, 1931. (A. Lacroix, Bull. Soc. Franç. Min., 1932, vol. 54 (for 1931), pp. 198–199.)

Bäckström (Helge Mattias) [1865–1932] was born at Örebro in Sweden on October 6, 1865, and died at Djursholm near Stockholm on July 15, 1932. He studied at Stockholm, Upsala, and Paris, and took the degree of Doctor at Heidelberg in 1891 with a thesis on the liparites of Iceland. Earlier papers in 1887 and 1888 dealt with the electrical and thermal conductivity of crystals and their thermo-electric properties. With W. C. Brøgger in 1888 dahllite was described as a new mineral, and in 1890 they published their classical paper on the chemical composition of minerals of the sodalite group which they regarded as alkali-garnets. After Brøgger's retirement

from Stockholm University (Högskola) in 1890, H. Bäckström became assistant there in 1891, and later (1908) Professor of Mineralogy and Petrology, from which post he retired in 1914. He prepared aegirine artificially in 1893, and in 1898 described large and remarkable crystals of phenakite from Kragerø in Norway. Other papers were petrographical; he described orbicular granites from Sweden and Spitzbergen, and a very fine slab of this rock from Kortfors in Örebro was presented by him to the British Museum in 1900. Bäckströmite was named after him by G. Aminoff in 1919. He was given the honorary degree of LL.D. of Montreal in 1913.

Bäckström afterwards took a prominent part in public affairs. He was a Member of the Swedish Parliament (1912–21), serving on various committees; a member of the board of the Swedish State Bank and of the National Debt Office. Since 1924 he was a prominent member of the Municipal Council and Chairman of the Finance Committee in Djursholm. He was also Chairman of the publishing firm of Tiden, member of the board of the Swedish Wine and Spirit Monopoly, Freys Express Company, Auditor of the Waterfalls Board, &c.

Baldauf (Richard Julius) [1848–1931], mining engineer and private collector of minerals, was born at Chemnitz on March 7, 1848, and died at Dresden on April 28, 1931. After taking the course at the Mining Academy at Freiberg in Saxony, his first work was at the Laurion mines in Greece. He was afterwards manager of coal mines in Saxony and owner of lignite mines in Bohemia. His extensive private collection of minerals, which included many rare species and large show specimens, was open free to the public and was described in detail in a guide-book (1922) [Min. Abstr., vol. 2, p. 485]. Late in life he went on collecting trips to Iceland, Greenland, Brazil, &c. A 'Richard Baldauf Festschrift', published as a special volume of the Society 'Isis' in Dresden on the occasion of his eightieth birthday, contains a biographical notice with portrait and an account of his museum. A rare phosphate mineral from Bavaria has been named baldaufite. (E. Rimann, Sitzungsber. u. Abhandl. Naturwiss. Gesell. Isis, Dresden, 1932, for 1931, pp. 9–15, with bibliography.)

Barker (Thomas Vipond) [1881–1931], distinguished as a crystallographer, was born at Darwen in Lancashire on March 7, 1881. From Kirkham Grammar School he went to Oxford in 1900, and

while still an undergraduate he obtained leave of absence for a year to study under P. Groth at München. Later, also at the suggestion of Sir Henry A. Miers, he spent more than a year (1908–9) in E. S. Fedorov's laboratory in Petrograd, where he assisted in the preparation of the Crystallo-chemical tables [M.A. **2**–100]. In 1909 he was appointed Demonstrator in the Mineral Department at Oxford, and in 1914 University Lecturer (later Reader) in Chemical Crystallography. He was also Secretary to the Delegates of the University Museum. Unfortunately for the science, he resigned from these appointments in 1928 to take the post of Secretary to the Curators of the University Chest. Dr. Barker's work was marked by a high degree of originality: he always preferred to try methods of his own. His first paper, published in this Magazine in 1903, was on quartz crystals. This was followed by three papers on the regular growth of crystals of one substance on those of another, in which he showed that such regular growths are governed by similarity in molecular volume. Numerous crystallographic determinations made by him on new organic compounds appeared in the papers of other authors. He published, largely at his own expense, three very original books: 'Graphical and tabular methods in crystallography' (1922), 'The study of crystals' (1930), and 'Systematic crystallography' (1930). In the last of these he explained in detail a new method of crystallo-chemical analysis [M.A. **4**–337], which is clearly an improvement on the Fedorov method. It is unfortunate that he was not able himself to bring this to a conclusion, but the work is being slowly continued at Oxford and in Holland [M.A. **5**–197]. He died on April 15, 1931, following an operation, at the early age of fifty. At a memorial meeting held in the Fedorov Institute in Leningrad resolutions were passed expressing 'our deep regret for the loss of this fine and good man, one of the most outstanding crystallographers of our time'. In the 'Internationaler Geologen und Mineralogen Kalender' for 1933–34, Th. Barker is still included in the long list of the staff of the Fedorov

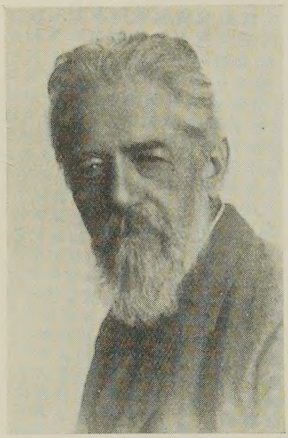
T. V. Barker (in 1927).

Institute. (Sir H. A. Miers, Journ. Chem. Soc., 1931, pp. 3344–3348. H. L. Bowman, Nature, London, 1931, vol. 127, p. 788. The Brazen Nose, Oxford, 1931, vol. 5, pp. 121, 148–149, 155–159.)

Barrow (George) [1853–1932], geological surveyor, was a member of this Society since 1893. For thirty-nine years (1876–1915) he was on the staff of the Geological Survey of Great Britain. Amongst much other geological work he made a special study of the metamorphic rocks of the Southern Highlands of Scotland and of Cornwall and Devon. Two of his papers on the metamorphic minerals around the Bodmin Moor granite were published in this Magazine in 1908–9. He died in London on July 23, 1932. (Sir J. S. Flett, Nature, London, 1932, vol. 130, p. 267.)

Becke (Friedrich Johann Karl) [1855–1931], Professor of Mineralogy in the University of Wien (Vienna), was an Honorary Member of our Society since 1909. He was born on December 31, 1855, at Praha in Bohemia and studied at Wien under G. Tschermak, A. Schrauf, and E. Ludwig, graduating in 1880. In 1882 he was appointed Professor of Mineralogy in the University of Czernowitz (now Cernauți in Romania) and in 1890 in the German University at Praha (Prag). In 1898 he succeeded A. Schrauf, and later G. Tschermak, at Wien, retiring in 1927. His first papers, in 1877, were on the crystallography of glaucodot, cassiterite, and vivianite, and in 1878 he turned to rocks from Greece. Later he issued a series of important monographs on the crystalline schists and metamorphism in the eastern Alps. In connexion with this petrographical work he devised special optical methods for the microscopical determination of rock-forming minerals. The immersion method for the determination of refractive indices was first used by him in 1893, and the bright line seen at the junction of the two media has since 1896 been universally known as the Becke line. This very simple method has done much to advance optical mineralogy. His method for the determination of plagioclase felspars from the optic axial angles led to a detailed study of skiodromes and isogyres. He also led the way in the study of etch-figures and of 'molecular axial ratios' (topic axes). Since 1899 he had acted as editor of 'Tschermaks Mineralogische und Petrographische Mitteilungen', and he was responsible for the last three editions of Tschermak's well-known 'Lehrbuch der Mineralogie'. A third volume of Zepharovich's 'Mineralogisches Lexicon für das Kaiserthum Österreich' with a detailed geographical index to the

three volumes was published by him in 1893. F. Becke was an Honorary Member of many academies and scientific societies, and he was awarded the Wollaston Medal by the Geological Society of London in 1929. On the occasion of his seventieth birthday, in 1925, a 'Festband' (Tsch. Min. Petr. Mitt., vol. 38) gave his portrait and a bibliography of his 256 published works. He died after a long illness on June 18, 1931. The accompanying portrait is a reproduction of the last photograph that was taken of him. (A. Himmelbauer, Tsch. Min. Petr. Mitt., 1932, vol. 42, pp. i–viii; Verh. Geol. Bundesanst. Wien, 1931, pp. 239–241; Almanach Akad. Wiss. Wien, 1932, pp. 290–295, with portrait. A. Lacroix, Compt. Rend. Acad. Sci. Paris, 1931, vol. 193, pp. 553–555. V. M. Goldschmidt, Nachrichten Gesell. Wiss. Göttingen, Geschäft. Mitt., 1932, for 1931–2, pp. 70–73. E. H. Kraus, Amer. Min., 1932, vol. 17, pp. 226–227, with portrait. C. E. Tilley, Quart. Journ. Geol. Soc. London, 1932, vol. 88, pp. lxiv–lxv. H. G. Backlund, Geol. För. Förh. Stockholm, 1931, vol. 53, pp. 329–337.)



F. Becke (in 1926).

Beckenkamp (Jakob) [1855–1931], Professor of Mineralogy and Crystallography in the University of Würzburg, was born at Horchheim near Coblenz on February 20, 1855. In 1872 he helped as a surveyor in re-mapping the Wiesbaden district. Later he entered the University of Bonn, where he studied mathematics, physics, and chemistry (1876–9); afterwards moving to Strassburg to study crystallography under P. Groth, where he graduated in 1881 with a thesis on the thermal dilatation of crystals. After training as a teacher, he taught in schools in Mülhausen, and also worked on the Geological Survey of Elsass-Lothringen. In 1897 he succeeded F. von Sandberger as Professor of Mineralogy and Geology at Würzburg, from which position he retired in 1929. His work in physical crystallography dealt with the thermal, elastic, magnetic, and electrical properties of crystals, and he published a long series of papers on the symmetry of crystals and their atomic structure. Some of his later

papers show a certain amount of tedious repetition and were privately printed. He also published as books, 'Statische und kinetische Kristalltheorien' (1913–15), and 'Leitfaden der Kristallographie' (1919). He died on January 12, 1931. (E. Schiebold, Centr. Min., Abt. A, 1931, pp. 257–269, with bibliography of 130 entries.)

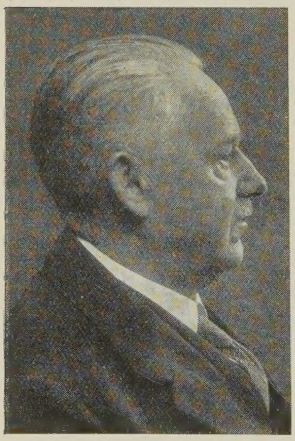
Beder (Robert) [1885–1930] was born on February 16, 1885, at Zürich, where he graduated in 1909 with a petrographical dissertation, afterwards studying at Paris and Heidelberg. In 1911 he migrated to Argentina, and for a short time was assistant in the Museum of Natural History of La Plata, becoming in 1912 a geologist on the Argentine Survey with especial charge of the museum. There he worked for twelve years investigating ore-deposits, especially those of wolfram. In 1914 he succeeded W. Bodenbender as Professor of Mineralogy and Petrology in the University of Córdoba. He died on November 19, 1930. (E. Kittl, Revista Minera, Argentina, 1930, vol. 2, p. 382; 1931, vol. 3, pp. 90–95, with portrait and bibliography. Schweiz. Min. Petr. Mitt., 1932, vol. 12, pp. 1–4, with portrait and bibliography.)

Bucca (Lorenzo) [1857–1930], Professor of Mineralogy in the University of Catania, was born at Palermo on November 23, 1857, and died on April 25, 1930. He had studied at Heidelberg under H. Rosenbusch and was later assistant to G. Strüver in Roma. In 1891 he was appointed Professor of Mineralogy and Geology in the University of Catania, and since 1903 of Mineralogy alone. His few papers are petrographical and on the crystallography of organic compounds. (S. Di Franco, Boll. Soc. Geol. Italiana, 1931, vol. 49, pp. lxxvi–lxxx, with portrait and bibliography.)

Bücking (Ferdinand Carl Bertram Hugo) [1851–1932], Emeritus Professor of Mineralogy and Petrology in the University of Strassburg (Strasbourg), was born at Bieber in Hesse on September 12, 1851, and died at Heidelberg on November 10, 1932. After studying at Göttingen and Leipzig he graduated at Marburg in 1874 with a mathematical thesis. In 1874–77 he was a geologist on the Prussian Geological Survey, in 1877–79 assistant to P. Groth at Strassburg, in 1881 Professor at Kiel, and in 1883 he succeeded Groth at Strassburg, when the latter was transferred to München. The last post he held until 1917, working at the same time on the

Geological Survey of Elsass (Alsace), of which he was afterwards Director. He also kept up his connexion with the Prussian Geological Survey till a later date when he resided in Heidelberg. H. Bücking's early papers dealt with various minerals, the first, in 1877, being on the optics of astrophyllite, and he determined several minerals occurring in the German salt deposits, including a new species, sulfoborite. He described euclase and herderite from the granite of Epprechstein in Bavaria, and bournonite and xanthoconite from St. Kreuz in Alsace. Many of his papers were petrographical, dealing with the igneous rocks of western Germany. He also wrote on the geology of the Dutch East Indies. His large collection of rock specimens from the Rhön Mts. and the Thuringian Forest was acquired by the British Museum in 1929–30. (R. Brauns, Centr. Min., Abt. A, 1933, p. 80.)

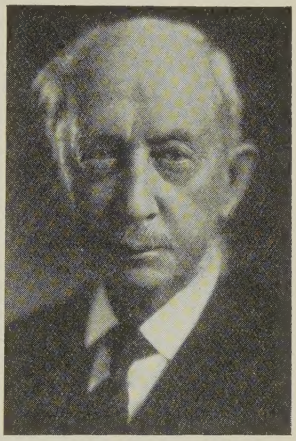
Busz (Karl Heinrich Emil Georg) [1863–1930], Emeritus Professor of Mineralogy and Geology in the Westphalian University of Münster, was born at Cleve in Rheinland on February 2, 1863. He was brought up at Bonn, which he always regarded as his home, and he was buried there; he died on December 8, 1930. He married an English lady, Edith Burbridge, and their only son, Dr. Karl Ernst Busz, is now with the well-known firm of Dr. F. Krantz in Bonn. After graduating in 1887 at Bonn, he was assistant under A. von Lasaulx, G. vom Rath, and H. Laspeyres in the Mineralogical Museum of that University until 1894. He then spent two years as assistant to Max Bauer at Marburg, and in 1896 became Professor of Mineralogy and Geology in the Academy at Münster, afterwards raised to the status of a University, of which Busz was Rector in 1910. His first work was done under H. von Dechen on the microscopical characters of the lavas of the Eifel (1885), and his doctor's dissertation dealt with the crystallography and optical characters of sphene. Kamarezite, manganosphaerite, phosphosiderite, and tsumebite were described by him as new mineral species, and a rare mineral



K. Busz (in 1926).

from South-West Africa has been named buszite after him [M.A. **4**–149]. He wrote a few papers on the rocks of Devonshire and Scotland, and was the first to record the presence of corundum in the contact-rocks of the Dartmoor granite. (R. Brauns, Centr. Min., Abt. A, 1931, pp. 57–61, with bibliography.)

Clarke (Frank Wigglesworth) [1847–1931], a well-known American chemist, was elected an Honorary Member of our Society in 1913. He was born at Boston, Massachusetts, on March 19, 1847, and died at Washington on May 23, 1931, at the ripe age of 84. After graduating at Harvard University in 1867, he acted as Instructor in Chemistry at Cornell and Harvard Universities. Later he was Professor of Chemistry and Physics in Howard University (Washington, D.C.) and the University of Cincinnati (Ohio), holding the latter post during the period 1874–83. For forty-two years (1883–1925) he was Chief Chemist of the United States Geological Survey; and during the same period he was also Honorary Curator of Minerals in the United States National Museum at Washington. While still engaged in teaching, he commenced the well-known series of numerical compilations under the title ' The Constants of Nature ', including, I, Specific gravities, boiling- and melting-points (1873); II, Specific heats (1876); III, Expansion by heat (1876); IV, Atomic weights (1880); V, Recalculation of atomic weights (1882). Some of these tables passed through several editions, and they led to his life-long work on American and International Committees on atomic weights, small committees of which he was usually the chairman. During his long connexion with the United States Geological Survey he was responsible for numerous chemical analyses of minerals and rocks, and the data obtained were tabulated in a series of Bulletins of the Survey. In other Bulletins he discussed in detail the chemical constitution of mineral silicates, the arguments being based on a large amount of experimental work made with a view of obtaining substitution products. His best-known work, also published as a Bulletin of the Survey, is his ' Data



F. W. Clarke (in 1922).

of Geochemistry', which passed through five editions (1908–24), and, with Dr. H. S. Washington, 'The Composition of the Earth's crust' (1924). He was also the author of elementary text-books on chemistry, and in later years he published several papers on the inorganic constituents of marine invertebrates. A new uranium mineral was named clarkeite in his honour only a week before his death. Professor Clarke by his genial personality and enthusiasm was well known in England, being an Honorary Member of the Geological and Chemical Societies and Honorary Doctor of Victoria and Aberdeen Universities. (W. T. Schaller, Amer. Min., 1931, vol. 16, pp. 405–407, with portrait. L. M. Dennis, Science, New York, 1931, vol. 74, pp. 212–213. L. J. Spencer, Journ. Chem. Soc. London, 1931, pp. 3348–3349. Nature, London, 1931, vol. 128, pp. 214–215. Quart. Journ. Geol. Soc. London, 1932, vol. 88, pp. lxv–lxvi.)

Crook (Alja Robinson) [1864–1930] was born at Circleville, Ohio, on June 17, 1864, and after graduating at the Ohio Wesleyan University in 1887, he spent three years studying in Europe, taking the doctorate of München in 1892 with a thesis on fossil fishes. In 1893 he was Professor of Mineralogy and Petrology in the Northwestern University at Evanston, Illinois, and in 1906 Curator of the Illinois State Museum at Springfield. He wrote but few papers; these deal mostly with museum work and administration, including a detailed guide to the mineral collection, and a mineralogy of the Chicago area. His last paper in 1930 was with O. C. Farrington on the Tilden meteorites. He died on May 30, 1930. (O. C. Farrington, Bull. Geol. Soc. Amer., 1931, vol. 42, pp. 19–25, with portrait and bibliography. A. J. Walcott, Amer. Min., 1931, vol. 16, pp. 102–103, with portrait.)

Currie (James) [1863–1930], shipowner, philanthropist, and a private collector of minerals, was born at Leith on April 13, 1863, and died at Edinburgh on November 3, 1930. He was a life-member of our Society since 1899, and contributed a paper on gyrolite and tobermorite to the Magazine in 1905. He took a mathematical degree at Cambridge in 1885 and was Honorary LL.D. of Edinburgh, Treasurer for many years of the Royal Society of Edinburgh, and President of the Edinburgh Geological Society in 1904–6. He wrote a valuable 'Mineralogy of Færöes', a few papers on Scottish zeolites,

and the section on Scottish pseudomorphs in M. F. Heddle's 'Mineralogy of Scotland'. His mineral collection, rich in zeolites, has been presented by his widow to the Geology Department of the University of Edinburgh. (T. J. Jehu, Proc. Roy. Soc. Edinburgh, 1932, vol. 51 (for 1931–32), pp. 202–204.)

Duparc (Louis Claude) [1866–1932], of Genève, took part in the jubilee celebration of our Society in 1926 and in that year he was elected an Honorary Member. He was born at Carouge near Genève on February 13, 1866, and died on October 20, 1932. He studied at Genève and Paris, and in 1888 was placed in charge of the Mineralogy course in the University of Genève, becoming soon afterwards Professor of Mineralogy, Petrography, Geology, and Palaeontology, and since 1900 also of Analytical Chemistry. His earliest papers in 1887 dealt with organic chemistry and the crystallography of organic compounds, but later he turned his attention to petrography, in which subject he was an energetic worker and a prolific author. A printed list 'Titres et publications scientifiques de Louis Duparc' (Genève, 1932, with portrait) comprises 355 titles. He did much work on the optical determination of the plagioclase felspars, and élaborated the Fedorov method with the universal microscope stage. He will be best remembered by his classical work (in collaboration with Miss M. N. Tikonowitch) 'Le platine et les gîtes platinifères de l'Oural et du monde', a large quarto volume published in 1920. He was also joint author of books on analytical chemistry and on optical mineralogy. For twenty years he had visited the Ural Mountains working out the geology and petrography more especially of the platinum-bearing districts. He also made voyages of exploration in connexion with mining enterprises to Romania, Morocco, Abyssinia, Madagascar, and many other countries, from which he always brought back some material of petrographical interest. Just before his death a supposed new mineral was described by one of his pupils under the name duparcite, which is really the

L. Duparc (in 1929).

same mineral from Morocco that Duparc had himself in 1927 named genevite. It shows only trivial and unessential differences from idocrase. (A long notice of Prof. Duparc has been written by M. Gysin for Schweiz. Min. Petr. Mitt., 1933, vol. 13, pp. 1–16, with portrait.)

Eakle (Arthur Starr) [1862–1931], Emeritus Professor of Mineralogy in the University of California at Berkeley, was born at Washington, D.C., on July 27, 1862. His father died while he was a boy and he had to earn his living as a clerk, but after attending night schools he entered Cornell University at the age of 25, where for four years he was Instructor in Mineralogy. During 1894–6 he studied under P. Groth in München, obtaining the degree of doctor for work on the crystallography of iodates and periodates. Returning to the United States he worked in the National Museum in Washington and at Harvard University, and in 1901 he went to the University of California as assistant to A. C. Lawson, becoming professor in 1919. After his retirement in 1930 he went on a visit to Honolulu, and becoming interested in the minerals of Oahu he stayed for a year. He died there on July 5, 1931, after an attack of influenza and pneumonia. Dr. Eakle wrote 'Mineral tables for the determination of minerals by their physical properties' (1904) and 'Minerals of California' (1914; 2nd edit., 1923). Of his several mineralogical papers mention may be made of those descriptive of the contact-metamorphic minerals at Crestmore in California, where he reaped a harvest of new species—crestmoreite, foshagite, jurupaite, riversideite, and wilkeite. Other new minerals described by him are erionite, esmeraldaite, palacheite, neocolemanite, probertite, and vonsenite. Some of these have not been confirmed: neocolemanite is the same as colemanite with another setting on the two-circle goniometer (Min. Mag. **16**–239). Eakleite, named after him by E. S. Larsen in 1917, was afterwards admitted to be identical with xonotlite. (C. Palache, Bull. Geol. Soc. Amer., 1932, vol. 43, pp. 46–52, with portrait and bibliography. W. T. Schaller, Amer. Min., 1932, vol. 17,

A. S. Eakle (in 1927).

pp. 94–95, with portrait. H. T. Stearns, Journ. Pan-Pacific Research Inst., 1931, vol. 6, no. 4, pp. 2–3.)

Elsden (James Vincent) [1856–1930], economic geologist, was a member of this Society since 1919. He was born at Hertford on August 1, 1856, and died at St. Leonards-on-Sea on October 31, 1930. For twenty years (1880–1900) he was partner in an Army coaching establishment. His 'Principles of chemical geology', written as a thesis for the London degree of D.Sc., was afterwards published as a book (1910). Other books are 'Applied geology', 'Practical stone quarrying', and (with J. A. Howe) 'The stones of London'. He was joint editor of several trade journals, and since 1913 Lecturer on Petrology and Economic Geology at University College, London. (Quart. Journ. Geol. Soc. London, 1931, vol. 87, pp. lxv–lxvi.)

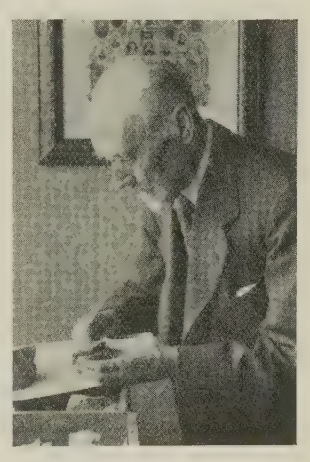
Evans (John William) [1857–1930], scholar, philosopher, and genius, was a member of this Society since 1891, and successively Treasurer (1918–24), Foreign Secretary, and Vice-President. He was born in the City of London, within the sound of Bow bells, on July 27, 1857, and he prided himself on being a true-born cockney. Many members of his family—his father, brother, sister, and wife—were medical practitioners, but he embarked on the legal profession, becoming a Barrister of Lincoln's Inn in 1878, Bachelor of Laws of the University of London in 1882, and later a Justice of the Peace. Turning to geology he studied at the Royal College of Science, where he gained the Murchison Medal in 1889 and acted as demonstrator until 1891. He then started a roving life, undertaking two long and difficult journeys of exploration in Bolivia and Brazil. Afterwards he was State Geologist of Kathiawar and later of Mysore, where he was also Chief Inspector of Mines and Explosives. Returning to London, he held appointments as special assistant in the Imperial Institute (1904–13), Lecturer in Geology at Birkbeck College (1906–20), and Lecturer in Petrology at the Imperial College of Science (1912–27). Since 1927 he was Chairman of the Geophysical Company, taking an active part in the prospecting work in the field, and again at the age of 70 he resumed a roving life, camping alone in the Sinai desert. Dr. Evans had many other activities. He was a Colonel of the old Volunteers and was awarded the Volunteer Officer's Decoration (V.D.). For his work at the Colonial Office in connexion with mineral surveys of the Colonies he was made C.B.E. in 1923. His published works cover a wide range of subjects

dealing with all branches of geology, igneous rocks and petrogenesis, the geometry of twinned crystals, the optical properties of crystals and improved pieces of optical apparatus, the symmetry relations and nomenclature of the thirty-two classes of crystals—and the possibility of life on Mars. Some of his papers appeared in this Magazine since 1900. He delighted in intricate and abstruse problems, bringing to bear a wide general knowledge, as well as a knowledge of languages, ancient and modern, and of mathematics. One such scholarly work, a paper of 47 pages on 'The meanings and synonyms of plumbago', was published in the Transactions of the Philological Society in 1908. He died on November 16, 1930. (W. W. Watts, Proc. Roy. Soc. London, Ser. B, 1931, vol. 107, pp. xxvii–xxx, with portrait. L. J. Spencer, Quart. Journ. Geol. Soc. London, 1931, vol. 87, pp. lxii–lxiv. A. Brammall, Geol. Mag. London, 1931, vol. 68, pp. 47–48. Nature, London, 1931, vol. 127, pp. 134–135.)

J. W. Evans (in 1930).

Flink (Gustaf) [1849–1931], Swedish mineral collector, dealer, and investigator, was born at Ås in Skaraborg on January 18, 1849, and died at Älvsjö on January 11, 1931. From 1871 until 1904 he was a teacher in an elementary school (Folkskola) in Stockholm, and for a time (1902–5) he owned and worked a small farm at Finja in Skåne. In 1881 he studied chemistry under O. Pettersson, and in 1883 mineralogy under W. C. Brøgger in the University (Högskola) of Stockholm. During one period (1905–16) he was assistant, as successor to G. Lindström, in the Mineralogical Department of the Natural History Museum (Riksmuseet) at Stockholm. He made many expeditions for the purpose of collecting minerals, which he sold to museums and private collectors (to the British Museum since 1892): twice to Iceland in 1883 and 1893; Greenland in 1897; and twelve times to the Urals in 1889–1916. He produced many good mineralogical papers and was a keen collector of new minerals. His discovery of the important mineral locality of Narsarsuk in the Julianehaab district, south Greenland, yielded a rich harvest of

thirty-four species, nine of which he described as new. Later he did intensive work on the minerals of Långban in Sweden, and in his enthusiasm he listed 423 undetermined minerals from this locality, several of which he described as new species, but eventually he became involved and confused. The following is a list of the thirty-seven new names introduced by him since 1886, many of which represent well-established species: akrochroite, ancylite, chalcolamprite, cordylite, dixenite, eisenpyrochroite, ektropite, endeiolite, epididymite, harstigite, heliophyllite, iron-schefferite, katoptrite, langbanite, leucosphenite, lorenzenite, manganomagnetite, molybdophyllite, narsarsukite, neptunite, ochrolite, pinakiolite, platynite, pseudoparisite, pyrobelonite, quenselite, rhodotilite, soda-catapleiite, sphenomanganite, spodiophyllite, synchysite, tainiolite, trigonite, trimerite, weibullite, weslienite, yttrium-apatite. His useful Mineralogy of Sweden (Bidrag till Sveriges mineralogi), of which four parts were published in 1908–17, unfortunately remains incomplete and unindexed. He was awarded the honorary degree of Ph.D. by the University of Upsala in 1900. Flinkite was named after him in 1889. A portion of his collection of Långban minerals was purchased by Harvard University. (G. Aminoff, Geol. För. Förh. Stockholm, 1932, vol. 54, pp. 233–240, with portrait and bibliography; the date of death is there given incorrectly as 1932.)



G. Flink.

Gregory (John Walter) [1864–1932], a most energetic and versatile worker and writer, was a member of this Society since 1892. Born in London on January 27, 1864, he was for a number of years (1879–87) in business with his father as a wool merchant. In the meantime by private study he graduated in the University of London, and in 1887 he entered the Geological Department of the British Museum, where he produced monographs on fossils. In 1900 he was appointed Professor of Geology and Mineralogy in the University of Melbourne and Director of the Geological Survey of Victoria; and afterwards (1904–29) Professor of Geology in the University of

Glasgow. One of the many subjects on which he wrote was that of ore-deposits. He attempted to settle the question 'What is a mineral?' (1909), and he translated from the Russian F. Levinson-Lessing's 'Tables for the determination of rock-forming minerals' (1893). He was a great traveller and explorer and received medals from several Geographical Societies. His last expedition to the Andes of Peru ended disastrously on June 2, 1932. (P. G. H. Boswell, Obituary Notices of Fellows of the Royal Society, London, 1932, no. 1, pp. 53–59, with portrait. Sir J. S. Flett, Nature, London, 1932, vol. 129, pp. 930–931.)

Hatch (Frederick Henry) [1864–1932], a member of this Society since 1910, was born in London and educated at University College, London, and the University of Bonn (1883–86), where he graduated Ph.D. For six years (1886–92) he was on the staff of the Geological Survey of Great Britain, working mainly on the petrology of the igneous rocks of Scotland. He then adopted the profession of a mining engineer and geologist, in which he was eminently successful, going first to the Witwatersrand, Transvaal, and afterwards visiting Canada, the United States, Spain, India, Abyssinia, Natal, Urals, and Siberia. Lastly he was technical adviser on metalliferous mining to the Mines Department in London. During 1910–13 he lived in Cambridge, where he lectured on economic geology, and he arranged in the Sedgwick Museum and presented to the University a fine collection of metallic ores. He was the author or joint author of a number of books, notably his 'Introduction to the study of petrology' (1891; 8th edition, 1926), which has had a considerable influence on the study of petrology in England. Other books are his popular 'Mineralogy' (1892), which passed through several editions, 'The gold mines of the Rand' (1895), 'Geology of South Africa' (1905 and 1909), 'Mining tables' (1907), 'An introduction to the study of ore-deposits' (1929), and several reports on mining and mineral resources. He was a past President of the Institution of Mining and Metallurgy and of the Geological Society of South Africa. One of the rare minerals from the Binnenthal, Switzerland, was named hatchite after him. He died in London on September 22, 1932. (R. H. Rastall, Nature, London, 1932, vol. 130, p. 602.)

Headden (William Parker) [1850–1932], agricultural and mineralogical chemist, was born near Red Bank, in New Jersey, on Sep-

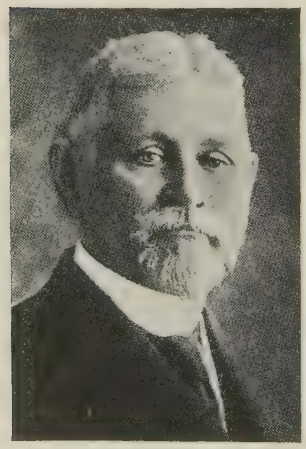
tember 21, 1850, and died on February 5, 1932. He graduated at Dickinson College in Pennsylvania in 1872, and at the University of Giessen in 1874, and had worked in R. Fresenius's laboratory at Wiesbaden. After acting as an assistant to F. A. Genth in the University of Pennsylvania, he was Professor of Chemistry in the Maryland Agricultural College, the University of Denver, and the State School of Mines of South Dakota. Since 1893 he was Professor of Chemistry and Geology in the Colorado Agricultural College and Chemist to the Agricultural Experimental Station at Fort Collins, Colorado. He wrote several short papers on minerals, especially those of South Dakota and Colorado, and he described griphite, kehoeite, and doughtyite as new species. A large number of experiments were made on the luminescence of calcite (1906 ; 1923–4 [M.A. **2**–495]), and detailed chemical analyses were made of the impurities extracted from large quantities of material, but he found that the differences in colour could not be attributed to the impurities present. He also investigated various crystallized furnace products, and amongst these he was the first to detect stannous sulphide.

Hiki (Tadasu) [1866–1927] was born at Fukui, in central Japan, on May 16, 1866, and died at Kyoto on June 23, 1927. After graduating in geology at the University of Tokyo in 1894, he worked as a research student on Japanese minerals, his well-known work on the topaz crystals of Mino being done during that period. In 1898 he was appointed Assistant Professor of Mineralogy and Geology in the Technological College of the University of Kyoto, and promoted to Professor in 1919, from which he retired in 1926. He wrote many articles on the minerals and ore-deposits, mainly of central Japan.

Hinterlechner (Karl) [1874–1932], Austrian geologist, was born at Laibach, in Carniola (now Ljubljana in Slovenia, Yugoslavia), on May 31, 1874, and died there on October 26, 1932. He studied at Wien (Vienna) under G. Tschermak and E. Suess, and for a time (1898–1900) was assistant in the German Technical High School at Brünn (Brno) in Moravia. Afterwards (1900–18) he was on the staff of the Austrian Geological Survey engaged in mapping in Bohemia and Moravia. In 1918 he was appointed Professor of Geology and Mineralogy in the new University at Ljubljana. His papers dealt mainly with the petrography of Bohemian rocks. (W. Hammer, Verh. Geol. Bundesanst. Wien, 1932, pp. 147–149.)

Johansson (Karl Fredrik) [1866–1933], after taking the diploma of mining engineer in Stockholm, extended his studies in mineralogy and other subjects in the Universities of Stockholm, Paris, Wien, and Heidelberg. During that period he published in 1892 a paper on enstatite and its alteration products, and another on the crystallography of cerussite and calcite, and contributed a note on the crystallography of ammonium and platinum compounds. He then devoted himself to the profession of mining engineer, visiting many countries. Retiring about 1922, he established a private laboratory at Hedemora, his birthplace, in Sweden. Working there, and partly also in the Natural History Museum at Stockholm, he produced in 1924 two excellent mineralogical papers describing the new species gladite, hammarite, lindströmite, and wittite. In 1928 two further species, gudmundite and haematophanite, were described, and in 1930 a valuable paper giving detailed chemical, optical, and X-ray data for members of the amphibole group [M.A. **4**–356]. He died suddenly on February 9, 1933.

Kunz (George Frederick) [1856–1932], a foremost expert on precious stones, was a member of our Society since 1885. He was born in New York on September 29, 1856, and educated at the Cooper Union of Arts and Sciences, where in 1875–76 he was assistant in the chemical laboratory. While still a boy he made and sold extensive collections of minerals. Since 1879 he was a Vice-President of the world-famous jewellers, Tiffany & Co., of New York, and since 1904 Honorary Curator of Gems in the American Museum of Natural History. He was a most energetic, indeed restless and impulsive, man with a striking personality, and was prominent in public movements of various kinds, including several international exhibitions. Since 1883 he was the author of a large number of short papers on minerals, precious stones, meteorites, and folklore, and he also produced several handsome volumes: 'Gems and precious stones of North America' (1890), 'The book of the pearl' (1908), 'The curious



G. F. Kunz.

lore of precious stones' (1913), and 'The magic of jewels and charms' (1915). The sumptuous volumes, 'Investigations and studies in jade' (1906), describing the H. P. Bishop Collection, were edited by him. Since 1882 he had given valuable annual reports on the production of precious stones, the earlier reports appearing in the publications of the United States Geological Survey, and later ones in the 'Mineral Industry'. Annual reports on the platinum metals were also issued over a long period. His great interest in gem-stones is commemorated in the name 'kunzite' for the lilac-coloured gem variety of spodumene. Dr. Kunz was an Officer of the Legion of Honour (France), Knight of the Order of St. Olaf (Norway), and Officer of the Rising Sun (Japan). He died on June 29, 1932. (H. P. Whitlock, Science, New York, 1932, vol. 76, p. 75; Natural History, Journ. Amer. Mus. Nat. Hist., 1932, vol. 32, p. 554, with portrait; Amer. Min., 1933, vol. 18, pp. 75–77. R. Brauns, Deutsche Goldschmiede-Zeitung, 1932, vol. 35, no. 32, p. 2. P. F. Kerr, Amer. Min., 1933, vol. 18, pp. 91–94, with portrait.)

Mügge (Johannes Otto Conrad) [1858–1932], Emeritus Professor of Mineralogy in the University of Göttingen. He graduated as a pupil of C. Klein at Göttingen in 1879 with a thesis on the crystallography of some organic compounds, and he returned there as Professor in 1908, in which post he was succeeded by V. M. Goldschmidt in 1928. In the meantime he acted as assistant to H. Rosenbusch at Heidelberg (1879–82), as curator of the mineral collection in the Natural History Museum at Hamburg (1883–86), Professor of Mineralogy in the Academy at Münster (1886–96 when he was succeeded by K. Busz), and Professor of Mineralogy and Geology in the University of Königsberg (1896–1908). Otto Mügge's work dealt mainly with physical crystallography. For many years he had made a special study of glide-planes and the deformation of crystals. He was one of the first to study the pleochroic haloes in minerals due to radioactivity.

O. Mügge (in 1927).

A useful paper was one published in 1903 in which he brought together all the known examples of the regular intergrowth of different mineral species. Some of his papers were petrographical with particular reference to metamorphic rocks. The fifth edition of vol. 1, part 2 of H. Rosenbusch's classical work 'Mikroskopische Physiographie der Mineralien und Gesteine', treating in considerable detail with the rock-forming minerals, was entirely re-written by him, forming a volume of 814 pages. He was born at Hannover on March 4, 1858, and died at Göttingen on June 9, 1932, while still engaged in work, and two of his papers were published after his death. His portrait appeared in a 'Festschrift Otto Mügge' (Neues Jahrb. Min., 1928, Beil.-Bd. 57) forming two thick volumes, which subscribers to the Jahrbuch had to take at a very high price. (H. Rose, Centr. Min., Abt. A, 1932, pp. 401–425, with bibliography of 150 entries. A. Johnsen, Forschungen und Fortschritte, 1932, vol. 8, p. 263.)

Oebbeke (Konrad) [1853–1932], Emeritus Professor of Mineralogy and Geology in the Technical High School at München (Munich), was born at Hildesheim in Hannover on November 2, 1853, and died on February 1, 1932. After studying at Heidelberg and Erlangen, he graduated at Würzburg in 1877, and was then an assistant on the Geological Survey of Bavaria and docent in the University of München. In 1887 he became Professor of Mineralogy and Geology in the University of Erlangen, and in 1895 in the Technical High School at München, retiring in 1927. He wrote on Bavarian minerals, more especially those of economic value, and he drew attention to the well-crystallized minerals in cavities in the granite of Epprechstein in the Fichtelgebirge, a good set of which he presented to the British Museum in 1910. He was responsible for the 12th–16th editions of F. von Kobell's Tables for the determination of minerals, and with E. Weinschenk for the 6th and 7th editions of F. von Kobell's Mineralogy.

Parry (John) [1863–1931], Chief Chemist of De Beers Company at Kimberley, South Africa, was born at St. Pancras, London, on November 25, 1863, and died at Kimberley on October 6, 1931. He started his career in the chemical laboratory of Epps, the well-known homocopathic chemists and cocoa manufacturers, and after serving his time with that firm he worked for a number of years in Leicester. On account of his health he went to South Africa in 1899, working in Cape Town and afterwards in Kimberley as a pharmaceutical

chemist. As a result of his brilliant research work he was invited by De Beers to start the Company's Analytical Department in 1917. There he analysed and described in joint papers published in this Magazine the new minerals afwillite and bultfonteinite from the diamond mines. A large number of his analyses of minerals and rocks from the diamond mines are published in A. F. Williams's recent (1932) book 'The genesis of the diamond'. On p. 172, vol. 1, of that work the name parryite appears for a still undescribed mineral.

Penrose (Richard Alexander Fullerton, *Jr.*) [1863–1931], mining geologist, was born at Philadelphia on December 17, 1863, and died there on July 31, 1931. He took his doctorate at Harvard University in 1886 with a thesis 'Nature and origin of deposits of phosphates of lime', which with some additions was afterwards (1888) published as a Bulletin of the United States Geological Survey. He was for a time attached to that Survey and also to those of Texas and Arkansas. From 1895 to 1911 he was Professor of Economic Geology in the University of Chicago, and he was one of the founders and first editors of the 'Journal of Geology' (Chicago, 1893). He was a member of many scientific societies and a director of several mining companies. He was unmarried and left an estate of over ten million dollars; after handsome bequests to the 'Journal of Geology' and 'Economic Geology', the residue was bequeathed in equal parts to the American Philosophical Society at Philadelphia and the Geological Society of America. A mineral has been named penroseite after him. (J. Stanley-Brown, Bull. Geol. Soc. Amer., 1932, vol. 43, pp. 68–108, with portrait and bibliography. R. T. Chamberlain, Journ. Geol. Chicago, 1931, vol. 39, pp. 756–760, with portrait. A. Schuchert, Amer. Journ. Sci., 1931, ser. 5, vol. 22, pp. 479–480.)

Repossi (Emilio) [1876–1931], Professor of Mineralogy in the University of Torino (Turin) since 1923, was born at Milano on June 19, 1876, and graduated at the University of Pavia in 1900. Until 1920 he was assistant to E. Artini in the section of mineralogy in the Civic Museum of Natural History at Milano, and afterwards Professor of Mineralogy in the University of Cagliari. He wrote on Italian rocks and minerals, and he gave the name gavite to a variety of talc from the Gava valley. He died on October 25, 1931. (M. Fenoglio, Boll. Soc. Geol. Italiana, 1931, vol. 50, pp. cxxxi–cxxxvi, with

portrait and bibliography. M. De Angelis, Atti Soc. Ital. Sci. Nat. Milano, 1931, vol. 70, pp. 271–278, with portrait and bibliography.)

Rinne (Friedrich Wilhelm Berthold) [1863–1933], an Honorary Member of this Society since 1926, was born at Osterode in the Harz on March 16, 1863, and died of pneumonia at Günterstal near Freiburg in Baden on March 12, 1933, a few days before his seventieth birthday. He graduated at Göttingen in 1883 with a dissertation on the crystallography of some organic compounds, then becoming assistant there to C. Klein. He accompanied Klein to Berlin in 1887, where he also acted as curator in the Mineralogical Museum of the University. In 1894 he was appointed Professor of Mineralogy and Geology in the Technical High School at Hannover, and succeeded O. Mügge at the University of Königsberg in 1903, R. Brauns at Kiel in 1908, and F. Zirkel as Professor of Mineralogy and Petrology at Leipzig in 1909. From the last post he retired in 1928 with the title of Emeritus Professor, and then became Honorary Professor in the University of Freiburg in Baden, where he continued to work with energy and enthusiasm. In 1899 he visited the Dutch East Indies, and wrote on the geology and petrology of Celebes; in 1900 the Philippine Islands, and in 1904 Kiaochow in China. He was always an enthusiastic worker with many new ideas, covering a wide range of subjects in mineralogy, crystallography, and petrology—and a prolific author. In some of his early papers and in most bibliographies and books of reference his name appears as Fritz Rinne, but later titles give Friedrich Rinne as the author. For many years he made a detailed study of the changes which zeolites and other hydrated minerals undergo when water is lost, introducing a number of new terms of the type metascolecite. In connexion with this work and also with his conception of isotypes amongst crystals, he was quick to recognize the importance of the new X-ray methods, and with his pupils at Leipzig intensive work was done. For the study of the fine structure of crystals he suggested the term ' leptonology ', and

F. Rinne.

his small book on this subject passed through several editions and was translated into English. Another successful book was his 'Gesteinskunde für Techniker' (1901; 10th edition, 1928). The methods of petrography he applied to the study of the German salt deposits and he showed that some of these have the characters of metamorphic rocks. One salt mineral was named koenenite by him, and another has been named rinneite after him. In later years he was led from the study of liquid crystals and 'living crystals' to a connexion between crystals and life; and some of his latest papers are difficult to follow. In anticipation of the celebration of his seventieth birthday laudatory notices with portraits appeared just too soon in Centr. Min., Abt. A, 1933, pp. 81–82, and Tschermak's Min. Petr. Mitt., 1933, vol. 44, pp. i–ii.

Sauer (Gustav Adolf) [1852–1932] graduated at Halle in 1876 with a dissertation on the phonolitic rocks of the Canary Islands. He was a geologist on the Surveys of Saxony and Baden, and the first Director of that of Württemberg. For many years (1900–23) he was Professor of Mineralogy and Geology in the Technical High School at Stuttgart. The mineral riebeckite was discovered by him in the granite of Socotra in 1888, and in the same year it was determined independently by T. G. Bonney and A. Harker in the Mynydd Mawr rock in Carnarvonshire [Min. Mag. **8**–167]. Other mineral names given by A. Sauer are graphitoid, kryptotile, and prismatine. He wrote a popular book 'Mineralkunde' with 26 coloured plates in quarto (1906–7). He died on May 2, 1932. (M. Bräuhäuser, Jahresber. Oberrhein. Geol. Ver. Stuttgart, 1933, vol. 21, pp. ix–xv, with portrait and bibliography. Jahresh. Ver. Naturk. Württemberg, 1933.)

Termier (Pierre) [1859–1930], Director of the Geological Survey of France and Inspector-General of Mines, was born at Lyon on July 3, 1859, and died on October 27, 1930. He was educated at the Polytechnic School and the School of Mines in Paris, and after acting as an Engineer of Mines at Nice he was appointed Professor of Geology, Mineralogy, and Physics in the School of Mines at Saint-Étienne. In 1894 he succeeded E. Mallard as Professor of Mineralogy and Petrology in the School of Mines in Paris. He had been attached to the Geological Survey of France since 1886, and in 1911 succeeded A. Michel-Lévy as Director. He was three times President of the French Mineralogical Society and also of the Geological Society of France. His principal work was on the structure of the Alps and

the petrography of their rocks, but he also published many mineralogical papers, discussing, for example, the relations between zoisite (of which he distinguished two optical varieties) and epidote. The clay mineral leverrierite was described by him, and another clay mineral has been named termierite. (E. Raguin, Bull. Soc. Géol. France, 1932, ser. 5, vol. 1 (for 1931), pp. 429–495, with portrait and bibliography. G. Aichino, Boll. R. Uff. Geol. Italia, 1930, vol. 55, no. 12, pp. 1–4, with portrait. Quart. Journ. Geol. Soc. London, 1931, vol. 87, pp. lx–lxii.)

Vogt (Johan Herman Lie) [1858–1932] was born at Tvedestrand in Norway on October 14, 1858, the son of a physician; his mother was a sister of M. S. Lie, the celebrated mathematician. He took the diploma of mining engineer in the University of Christiania in 1880, and afterwards studied at Stockholm, Freiberg, Clausthal, and Aachen. In 1886 he was appointed Professor of Metallurgy in the University of Christiania (now Oslo), and in 1912 Professor of Mineralogy and Geology in the Technical High School at Trondhjem, from which post he retired in 1928 and was succeeded by his son Thorolf Vogt. His first important work, in 1884, was on the crystallized constituents of furnace slags: one of these he named åkermanite, which has since been recognized as a constituent of minerals of the melilite group. Another crystallized slag product has been named vogtite. A set of the crystallized slags which he had described was acquired by the British Museum in 1891. The study of slags led to a comparison with lavas, on which he published three papers in 1889–90, and later to an intensive study of igneous magmas from a physical chemical standpoint, resulting in a long series of papers: 'Die Silikatschmelzlösungen' (1903–5), 'Physikalisch-chemische Gesetze der Krystallisationsfolge in Eruptivgesteinen' (1905–8), 'Ueber anchi-monomineralische und anchi-eutektische Eruptivgesteine' (1909), 'Die Sulfid-Silikat Schmelzlösungen' (1919), 'The

J. H. L. Vogt.

physical chemistry of the magmatic differentiation of igneous rocks' (1923–31). Vogt was an equally prolific author on the subject of ore-deposits. He produced several reports for the Geological Survey of Norway and also that of Sweden, and long papers on magmas and igneous ore-deposits. He was joint author with F. Beyschlag and P. Krusch of a treatise 'Die Lagerstätten der nutzbaren Mineralien und Gesteine' (1910–13), which was translated into English by S. J. Truscott (1914–16). He died on January 3, 1932. (C. W. Carstens, Tschermaks Min. Petr. Mitt., 1933, vol. 44.)

Wegener (Alfred Lothar) [1880–1930], German meteorologist and propounder of the much-discussed hypothesis of continental drift, was born in Berlin on November 1, 1880, and perished on his fourth expedition to Greenland in 1930. He graduated at Berlin in 1905 with an astronomical thesis, and in 1924 was appointed Professor of Meteorology and Geophysics in the University of Graz in Styria. He wrote a few papers on meteors, and his calculation of the path of the meteor of April 3, 1916, led to the finding of the Treysa meteorite [M.A. **1**–102]. The craters on the moon and also those in Estonia he attributed to the fall of meteorites [M.A. **5**–17]. (H. Benndorf, Gerlands Beitr. Geophysik, 1931, vol. 31, pp. 337–377, with portrait and bibliography. W. Schmidt, Almanach Akad. Wiss. Wien, 1931, pp. 321–328.)

Woodward (Charles Josiah) (1838–1932] was one of the few select members of the Crystallological Society, which was founded in 1876 and amalgamated with the Mineralogical Society in 1883, and since then he was a life-member of our Society. He was born in June 1838, the son of a japanner in Birmingham, and he had a long connexion of over seventy years with the Midland Institute in that city, where he was first attracted by the Penny Lectures in 1856. He became assistant there in 1859, lecturer in 1863, and in 1890 Principal of the Chemistry and Physics Department of the Technical School. He wrote on the minerals of Lilleshall in Shropshire (1883) and of the Birmingham district (1886); small books 'ABC five-figure logarithms' (1893 and 1908) and 'Crystallography for beginners' (1896); and on artificial crystals of gypsum (Min. Mag., 1907). He died on March 12, 1932, at the advanced age of nearly 94. (Portraits and biographical notes in The Institute Magazine, Birmingham, 1892, part 82; 1931, part 361.)

Wülfing (Ernst Anton) [1860–1930], Emeritus Professor of Mineralogy and Petrology in the University of Heidelberg, was born on November 27, 1860, at Elberfeld in Rheinland, and died on December 17, 1930, at Bad Wörishofen in Bavaria, where he had gone on account of his health. He studied chemistry at Genève and under Bunsen at Heidelberg, where he graduated in 1884, and in 1886 he was assistant to A. W. von Hofmann at Berlin. He afterwards turned to mineralogy and geology, studying at Greifswald and Wien in 1887–88, and then became assistant to H. Rosenbusch at Heidelberg, whom he succeeded in 1908. In the meantime he was professor successively at the University of Tübingen (1891–99), the Agricultural Academy at Hohenheim in Württemburg (1899–1904), the Technical High School at Danzig (1904–7), and the University of Kiel (1907–8). Wülfing made careful chemical and optical determinations on various minerals—pyroxenes, tourmalines, plagioclases, &c., and he introduced several improvements in optical apparatus. He devised a simple hand apparatus for cutting orientated sections and prisms from crystals, and also various models for demonstration purposes. A notable and laborious piece of work is his ' Die Meteoriten in Sammlungen und ihre Literatur ' (Tübingen, 1897), which will always remain a useful book of reference. He was responsible for volume 1 of the fourth edition of H. Rosenbusch's ' Mikroskopische Physiographie der Mineralien und Gesteine ' (1904–5), and he edited the ' Festschrift H. Rosenbusch ' (1906). (E. Ernst, Centr. Min., Abt. A, 1931, pp. 128–135, with bibliography.)

E. A. Wülfing.

Zambonini (Ferruccio) [1880–1932], a brilliant and energetic worker, has been lost to Italian science at the early age of 51. He was born at Roma on December 17, 1880, and died at Napoli (Naples) after an attack of influenza on January 12, 1932. After graduating in 1903 he was assistant in chemistry in the Engineering School at Torino (Turin), and afterwards (1906–9) assistant in mineralogy to E. Scacchi at Napoli. He was then Professor of Mineralogy successively in the

Universities of Sassari (1909–10), Palermo (1910–13), and Torino (1913–22). In 1922 he was appointed Professor of General Chemistry in the University of Napoli, where at the time of his death he was Rector (Rettore Magnifico). He commenced analysing and describing Italian minerals at the age of seventeen, and a year later he rather rashly ventured on the description of two new minerals which have not been substantiated. One of these, müllerite, having been given a preoccupied name, was renamed zamboninite by Max Bauer in 1901. More recently, in 1930, the name zamboninite has been applied to a fluoride of magnesium and calcium from Etna. His name, grothine (1913), was equally unfortunate, and others of his supposed new mineral species were based on analyses of unsatisfactory material. Altogether he introduced thirty mineral names, several of them as chemical varieties. In the analyses of the complex minerals strüverite (also a preoccupied name) and guarinite he sought the assistance of G. T. Prior, and joint papers were published in this Magazine in 1908 and 1909. His most lasting mineralogical work will be his valuable monograph 'Mineralogia Vesuviana' (1910, with appendix 1912). Later, usually in collaboration with his assistants G. Carobbi, V. Caglioti, R. G. Levi, and others, he did an enormous amount of work in chemical crystallography, especially on the isomorphism of complex compounds of the rare earths; but he still continued to publish valuable papers on mineralogy. A bibliography (by G. R. Levi, Zeits. Krist., 1932, vol. 82, pp. 142–149) of his published papers includes 168 titles. (F. Millosevich, Rend. R. Accad. Lincei, Cl. Sci. fis. mat. nat. Roma, 1932, ser. 6, vol. 15, pp. 767–776, with portrait and bibliography. A. Pochettino, Atti R. Accad. Sci. Torino, 1932, vol. 67, pp. 207–216. G. B. Alfano, Zeits. Vulkanologie, 1932, vol. 14, pp. 179–183, with portrait and bibliography.)

F. Zambonini.

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A later death is that of—Goldschmidt (Victor) [1853–1933], on May 8, at Salzburg.

A possible source of error in the determination of symmetry from optical extinction-angles.

By Max H. Hey, B.A., B.Sc.
Assistant-Keeper in the Mineral Department of the British Museum of Natural History.

[Read March 23, 1933.]

DURING an optical examination of many mesolite crystals with a view to a determination of their symmetry, the author was puzzled to find that whereas mesolite has generally been described as anorthic, on optical evidence, he could detect no trace of inclined extinction in the prism zone. A. Cavinato (1926)[1] and G. Cesàro (1909)[2] had already made similar observations. Further study revealed the probable causes of the discrepancies, and as these sources of error, and the precautions necessary for their avoidance, receive little or no mention in the principal text-books, an account of them might be of some use.

The monoclinic, pseudo-orthorhombic crystals of mesolite form prisms elongated along the *b*-axis and bounded by *r* (101), *R* ($\bar{1}$01), *o* (111), and *p* ($\bar{1}$11). There is general agreement on the optical behaviour of sections perpendicular to the *b*-axis, in which twinning on *a* (100) or *c* (001) is revealed. The discrepancies referred to are in the behaviour of natural and artificial plates parallel to the prism zone [010].

Since the optic axes are nearly perpendicular to the faces *r* and R, the natural prisms are not really suitable for examination. When lying perfectly at right angles to the microscope axis they give straight extinction, but the slightest inclination results in markedly inclined extinction. Small clean prisms were found to give straight extinction, but larger aggregates and parallel growths, which would not lie quite flat, gave extinction angles up to 12°. How this behaviour may constitute a source of error will be clear from fig. 1.

[1] A. Cavinato, Atti Soc. Ital. Sci. Nat., 1926, vol. 65, p. 104. [M.A. **4**–319.]

[2] G. Cesàro. Bull. Acad. Roy. Belg., 1909, p. 435. The crystallographic orientation used for mesolite in this note is that proposed by Cesàro.

A much more important source of error, and one that does not always appear to have been fully recognized, was exemplified by a section cut approximately perpendicular to the *c*-axis. The two cut faces were practically parallel, but measurement showed that they were not quite in the prism-zone [010], being inclined about $2\frac{1}{2}°$ to it; this small deviation from the desired position sufficed to give rise to extinction phenomena which would have led to the crystals

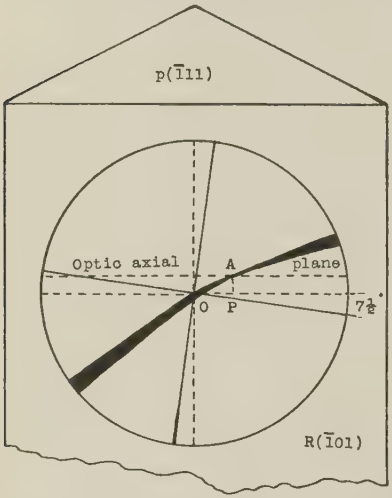

Fig. 1.

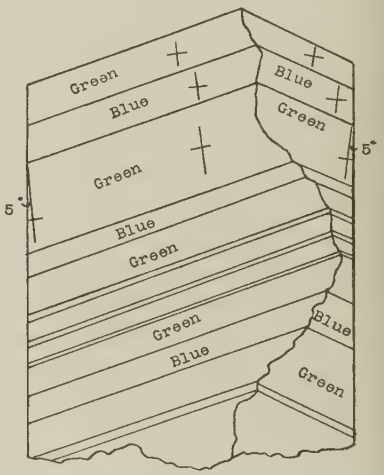

Fig. 2.

Fig. 1. Inclined extinction given by a mesolite crystal lying nearly on $R(\bar{1}01)$, but tilted 2° in the direction of $b(010)$. Optic axis A; $OP=8°$, $AP=2°$.

Fig. 2. Extinction phenomena shown by cut plate from a mesolite twin, inclined $2\frac{1}{2}°$ to $c(001)$ in the direction of $b(010)$. The main portion of the plate shows a light green interference-colour, traversed by blue bands.

being classed as anorthic but for a careful examination in convergent light. The plate (0·92 mm. thick) consisted of two portions in twin position, with a rather irregular boundary (fig. 2); the acute bisectrices of the two portions are inclined at some 15–20° to one another, and each is about 10° from the normal to the plate. In parallel light with the principal planes of the nicols perpendicular and parallel to the elongation of the crystal, extinction was not perfect in either portion of the twin, but the two portions matched; in the 45°-position, both portions showed a pale green interference-colour of the second order, traversed by bright blue bands parallel to the pyramid faces. In one member of the twin, the green field extin-

guished at about 5° to the elongation, the blue bands at about 4°, while the other member of the twin showed similar phenomena, the behaviour of the whole being symmetrical about the elongation (fig. 2).

This would appear to indicate anorthic symmetry in the crystal, but an examination in convergent light showed that the phenomena

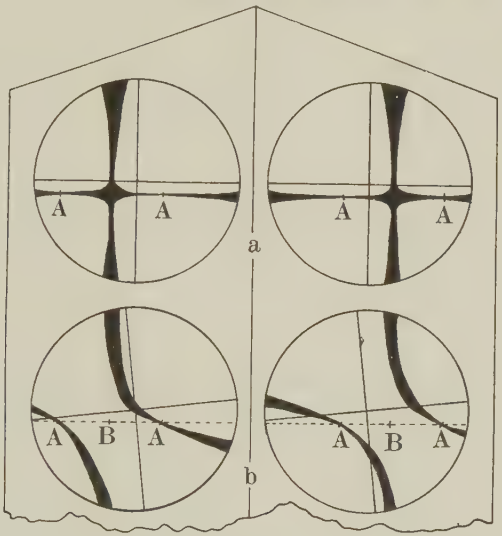

Fig. 3. Interference-figures shown in convergent light by a cut plate from a mesolite twin, inclined $2\frac{1}{2}°$ to $c(001)$ in the direction of $b(010)$. Optic axes A, A; bisectrix B.

(a) Nicols parallel and perpendicular to [010].

(b) Nicols at 5° to [010] and [100]; left half of the twin in extinction position.

are due solely to the plate being cut not quite perpendicular to the optic axial plane of the crystal. In both halves of the twin the optic axial plane was found to run slightly below the centre of the field, while the bisectrix was to the right of the centre in one half, to the left in the other. The blue bands proved to be due to regions with somewhat lower birefringence and smaller optic axial angle.

Figures 3 a and 3 b show how the apparently anomalous extinction phenomena arise. Since neither the optic axial plane nor the plane containing β and γ is quite perpendicular to the section, extinction

is not perfect in the expected position with the principal planes of the nicols perpendicular and parallel to the elongation of the crystal, but on examination in convergent light and rotating a few degrees, we see one axial brush in the figure for one half of the twin sweep across the centre of the field—complete extinction; rotation in the other direction is necessary to produce the same result in the other half of the twin. The blue bands, with a somewhat different optic axial angle, naturally require a somewhat different rotation. Calculation, by the formula of L. Duparc and F. Pearce[1] gives for a cut plate inclined at $2\frac{1}{2}°$ to β and 10° to γ, with $2V = 90°$, an extinction-angle of $4\frac{1}{2}°$ to the elongation, in good agreement with the observed value. The extinction-angle varies with the inclination of the plate and with the optic axial angle, being greater the more inclined the plate is to the optic axial plane, the more inclined it is to the bisectrix, and the greater the optic axial angle about that bisectrix which is nearly normal to the plate.

It has seemed desirable to go into some detail over these phenomena; partly because the behaviour of plates 'cut perpendicular to a bisectrix', but probably only approximately in the desired position, has appeared in the literature several times as evidence of the supposed anorthic symmetry of mesolite; and partly to call attention to the caution necessary in the optical study of natural [2] or artificial plates which are supposed to be perpendicular to a principal optic plane or axis of the crystal, a matter in which the text-books give no adequate warning of the possibilities of error. It seems to be frequently assumed that a displacement of the cut face by 1–2° from the desired position is of no importance, but this example of mesolite shows that such is not the case.

[1] L. Duparc and F. Pearce, Traité Techn. Min. Petr., Leipzig, 1907, part 1, p. 250.

[2] Vicinal faces, especially if somewhat irregularly developed, may at times cause a crystal laid on a slide to be $1-2°$ or more from the supposed position. Cleavage plates may also give false results if the cleavage face on which the plate is lying happens to be stepped to any extent.

The dehydration of thomsonite.

By A. E. Mourant, M.A., D.Phil.

[Read March 23, 1933.]

THE dehydration of thomsonite has recently been studied by Mr. M. H. Hey.[1] The work here described was carried out in the Mineralogy Department at Oxford in the years 1925 and 1926. At the suggestion of Mr. Hey the results, though inconclusive by themselves, are now published for comparison with his own, which were mostly obtained by a different method.

The material used was from a specimen of thomsonite and prehnite labelled ' Kilpatrick Hills, Scotland ' (Reg. No. 8660, Mineral Collection, Oxford University Museum). Its practical identity of composition and physical properties with that used in most of Hey's work shows that it almost certainly came from Bowling quarry, Old Kilpatrick, Dumbartonshire.

All the thomsonite used for quantitative work was kept in a desiccator over 20 % sulphuric acid. That used for dehydration was crushed down to cleavage prisms about 0·5 mm. in diameter. Further crushing was avoided owing to the danger of surface effects. The chemical composition and principal physical properties are given in table I. The cell-sides were kindly determined recently by Mr. F. A. Bannister and the refractive indices by Mr. M. H. Hey.

Low temperature dehydration.—Thomsonite was kept over slightly dilute sulphuric acid for several weeks and the loss of weight determined. Over 89·2 % acid 0·4611 gm. lost 0·0002 gm. in a day, and only 0·0001 gm. in the next month. The total loss amounts to 0·07 % or 0·12 mol. per unit cell. Over 95·6 % acid equilibrium was not reached in 89 days; after this period 0·31 % of water (0·55 mol. per unit cell) had been lost. The water vapour-pressure over 84·5 % sulphuric acid is 0·154 mm. Hg. That over stronger acids is unknown. Tammann[2] observed a loss of 0·008 % in the weight of thomsonite kept over 85·1 % sulphuric acid.

[1] M. H. Hey, Min. Mag., 1932, vol. 23, p. 51.

[2] G. Tammann, Zeits. Physikal. Chem., 1897, vol. 27, p. 323.

TABLE I. Thomsonite from Kilpatrick used for dehydration experiments.

Composition.			Atoms (and molecules H_2O) per unit cell, assuming O = 80.		
		%			
SiO_2	...	36·84	Si	...	19·76
Al_2O_3	...	31·64	Al	...	20·00
CaO	...	14·19	Ca	...	8·16
MgO	...	0·29	Mg	...	0·23
Na_2O	...	4·00	Na	...	4·16
K_2O	...	trace	—		—
H_2O	...	13·53	H_2O	...	24·20
Total	...	100·49			

Si + Al = 39·76 (40, theoretical).
Ca + Mg + Na = 12·55 (12 in 'normal' thomsonite).
Density = 2·381.
Cell-sides in Å.: a 13·07, b 13·07, c 13·23 (all ± 0·05). Oxygen atoms per unit cell (from cell-sides, density, and composition) = 80·97.
Refractive Indices: α 1·528, β 1·531, γ 1·543 (± 0·003).
$(\alpha+\beta+\gamma)/3 = 1·534$.

High temperature dehydration.—It was possible that the measurement of the water content of considerably dehydrated thomsonite would be complicated by the material absorbing considerable quantities of air as chabazite does. A series of gravimetric experiments suggested that absorption was negligible, but since they were not conclusive another test was made. Several small clear crystals were heated to 300° C. for a few hours and cooled overnight in a stream of dry air. Some were then rapidly transferred to a small quantity of water and observed for half an hour. Since changes in birefringence showed that hydration was still proceeding, some larger pieces were put under a small inverted test-tube and left for a day, at the end of which no air had appeared. It may therefore be concluded that dehydrated thomsonite does not absorb air appreciably.

It was therefore possible to use the isobaric method of dehydration for the quantitative work. Air was slowly driven by a water-pump through a saturating worm immersed in a thermostat and then passed over thomsonite which was heated to various temperatures; its water content was determined by weighing. The heating tube was of hard glass, surrounded by a tubular sand-bath similar to that of Friedel.[1] This was heated in a gas-furnace, the temperature being controlled by a pressure regulator followed by a mercury thermostat. The range of temperature seldom exceeded 0·5° C.

The thomsonite, originally weighing 1·4342 gm., was contained in a porcelain boat which was weighed in a bottle against a similar counterpoise. During heating at a given temperature it was weighed every day or two until the weight appeared constant. At the first

[1] G. Friedel, Bull. Soc. Franç. Min., 1896, vol. 19, p. 363.

three temperatures the attainment of equilibrium was then tested by lowering the temperature of the furnace three or four degrees and weighing again. The results obtained are tabulated in table II and shown graphically in fig. 1 in comparison with some of those obtained by Hey.

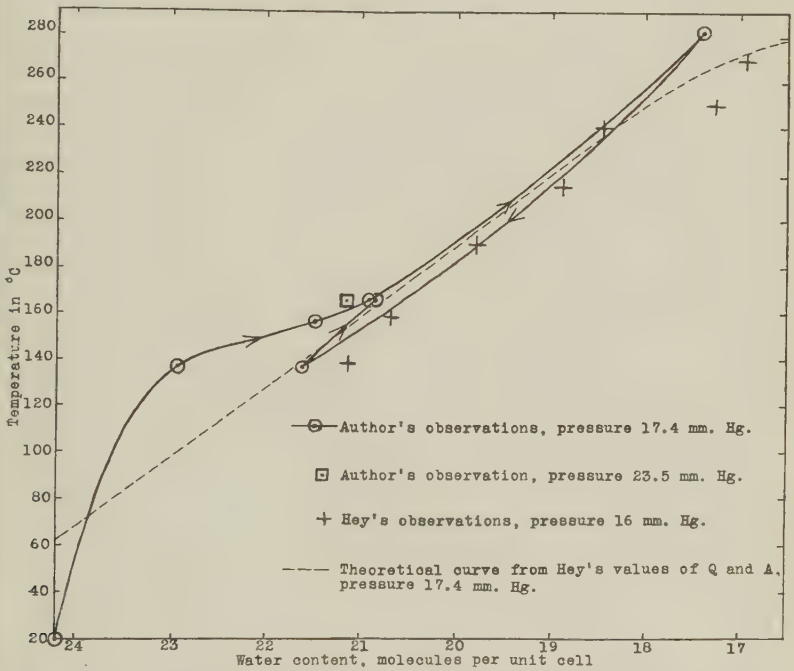

FIG. 1. Isobaric dehydration and rehydration of thomsonite. The abscissae correspond to the author's observed water contents but Hey's points are compared on the basis of water losses.

TABLE II. Observations on the dehydration of a single sample of thomsonite in the order in which they were made. Water vapour-pressure, 17·4 mm. Hg., except for the run marked *, where it was 23·5 mm. Hg.

Temperature °C.	Water content Mols. per unit cell.	Hours.	
20	24·20	—	† Equilibrium checked by lowering
136·2	22·93	121†	temperature slightly.
155·9	21·48	94‡	‡ Weight not quite steady but equi-
164·6	20·91	205†	librium shown to be practically
164·6*	21·14	109§	complete by lowering temperature.
282·3	17·38	103§	§ Weight steady; equilibrium not
134·3	21·61	284§	checked.
164·5	20·85	44‖	‖ Only one weighing.

The chief features of interest in the writer's curve are the 'hysteresis' loop and the point of inflection. The failure of the material to recover its original water content at about 135° C. after heating to 282° C. agrees with the observations of other workers, but it is surprising to find that after subsequent heating at 164·5° C. the zeolite has practically returned to its original composition at that temperature.

The general run of the curve is very close to those of Hey. The high water content observed by the writer round about 150° C. might at first sight be attributed to failure to reach equilibrium, but in each case equilibrium was confirmed by observing the increase in weight produced by lowering the temperature slightly for a few hours. The rapid change of water content in the neighbourhood of 156° C. was thus made particularly clear, for on lowering the temperature 3·6° C. two-thirds of the quantity of water required by the writer's curve was reabsorbed in nine hours. At the first heating to 164·6° C. equilibrium was almost certainly complete, for on raising the vapour-pressure to 23·5 mm. Hg. the gain in weight corresponded to 0·25 molecule as compared with 0·18 calculated from Hey's values for A and Q. Imperfect internal equilibrium of the zeolite might yet have allowed the recovery of weight on reducing the temperature from 136·2° C. and thus account for the considerable discrepancy between the curves at that temperature, but the differences at higher temperatures cannot be explained thus. The general correspondence between the curves would be somewhat improved if they were compared on the basis of water content instead of water loss, by moving Hey's curve 0·40 molecule to the left. The correspondence between Hey's theoretical curve and the actual course of the second heating is close but, in view of the above considerations, the loop in the writer's curve is probably genuine and due to lattice shrinkage and recovery.

The apparent recovery from shrinkage during cooling and reheating to 164·5° C. has been tested by Mr. F. A. Bannister, who has compared the lattice dimensions of the untreated thomsonite with those of the actual material which had been used in the above experiments and had then stood over 20 % sulphuric acid for six years. Unfortunately the acid itself had reached and slightly attacked some of the material so that its water content could not be determined reliably; but sufficient of the pure material was left for the X-ray work. The lattice dimensions of the untreated thomsonite are a 13·073, b 13·073,

c 13·23 Å., and the refractive indices α 1·528, β 1·531, γ 1·543. After the heat treatment and subsequent exposure over dilute acid, the cell-sides were a 13·048, b 13·048, c 13·23 Å., and the refractive indices α 1·524, β 1·527, γ 1·539. The probable maximum error in the cell sides is 0·05 Å., but the relative values of a and b before and after treatment are correct to $\pm$ 0·01 Å. The determinations of refractive index (made by Mr. M. H. Hey) are correct to $\pm$ 0·003.

The immediate effect of heating a specimen of thomsonite to 270° C. was shown by Mr. Bannister (this vol., p. 103) to be a contraction of a and b from 13·09 to 12·93 Å., a difference of 0·16 Å. Such a contraction must certainly have occurred in the material heated by the writer to 282° C., but the residual contraction is now only 0·025 Å., so that the substance has nearly recovered as suggested by the loop in the isobaric curve. It is not, however, certain to what extent the recovery took place in the later stages of heating (14 days at about 150° C.) and to what extent in the subsequent six years at room-temperature. The water content has not completely recovered. The refractive indices show it to be about one molecule per unit cell less than in the untreated substance.

The writer wishes to thank Prof. H. L. Bowman for suggesting the research, for his very helpful supervision, and for designing and largely constructing the heating apparatus. The work was carried out with the aid of a King Charles I Scholarship at Exeter College, Oxford.

The identity of mottramite and psittacinite with cupriferous descloizite.

By F. A. Bannister, M.A.

With chemical analyses by M. H. Hey, B.A., B.Sc.

Assistant-Keepers in the Mineral Department of the British Museum of Natural History.

[Read January 26, 1933.]

MR. ARTHUR RUSSELL collected in 1930 on Pim Hill, near the village of Harmer Hill, 6 miles north of Shrewsbury, Shropshire, specimens of Triassic sandstone encrusted with minute black crystals. They resemble very closely the material from Mottram St. Andrew, Cheshire, which was described and named mottramite by Sir Henry E. Roscoe in 1876.[1] Mr. Russell pointed out this resemblance and kindly placed his specimens of this rare British mineral at our disposal for investigation. During the course of identifying the incrustations it was found necessary to examine a number of specimens of closely allied minerals—descloizite, cuprodescloizite, psittacinite, &c. X-ray powder photography and chemical analysis were the methods used, and approximate optical data were obtained whenever possible. The specimens studied included as far as possible material from type localities, and are listed below :

I. Large black pyramidal crystals, labelled descloizite, yielding a pale-yellow powder; from Abenab, South-West Africa, collected by Dr. L. J. Spencer, 1929. (B.M. 1929,1946a.)

II. Large dark-brown pyramidal crystals with curved faces, labelled descloizite, yielding an olive-green powder; from Grootfontein district, South-West Africa. (B.M. 1930,296.)

III. Grass-green crystals, labelled cuprodescloizite, yielding a bright-green powder; from Uris mine, Tsumeb, South-West Africa. (B.M. 1931,22.)

IV. Olive-green botryoidal, fibrous mass, labelled mottramite, yielding an olive-green powder; from Nageib, Otavi district, South-West Africa. (B.M. 1929,1871.)

V. Thin incrustations of minute black crystals, yielding an olive-green powder; on sandstone from Pim Hill, Harmer Hill, Shrewsbury, Shropshire, collected by Mr. Arthur Russell, 1930.

[1] H. E. Roscoe, Proc. Roy. Soc. London, 1876, vol. 25, p. 111.

VI. Red, compact mamillary crusts, with A. Krantz's label 'dechenite', yielding an orange-yellow powder; from Niederschlettenbach, Lauterthal, Rhenish Bavaria. (B.M. 26521.) C. Bergemann [1] gave this name to a mineral collected by A. Krantz, and his chemical analyses suggested it to be a simple lead vanadate. Although G. J. Brush [2] and F. Pisani [3] detected the presence of zinc in material from the same locality, no quantitative chemical work on the mineral has been carried out since 1854. A. Krantz considered that araeoxene [4] from Dahn, Lauterthal, Rhenish Bavaria, is identical with dechenite. The two localities are only a mile apart, and Bergemann's [5] analysis of material from Dahn shows 10·52% As_2O_5.

The following specimens were examined only by X-ray powder photographs and optical methods, owing to insufficient material for chemical analysis:

VII. Siskin-green compact material from Iron Rod mine, Silver Star district, Montana, U.S.A. (B.M. 63521.) F. A. Genth [6] received in 1874 similar material from the same locality, which he erroneously described as a new tellurate of lead and copper. He did not analyse the mineral until 1876,[7] and then found it to be a copper lead vanadate which he named '"psittacinite" from psittacinus, siskin- or rather parrot-green'.

VIII. Thin black incrustations yielding an olive-green powder; on sandstone from Mottram St. Andrew, Cheshire. (B.M. 52314.) This specimen of the original mottramite was presented to the British Museum by Sir Henry Roscoe in 1879.

IX. Black crusts of iridescent crystals, labelled psittacinite, yielding an olive-green powder; from Shattuck-Arizona mine, Bisbee, Arizona, U.S.A. (B.M. 1913,383). This material is probably identical with that described by Wells [8] as cuprodescloizite and later renamed psittacinite by Schaller.[9]

X. Dark-green incrustations, yielding an olive-green powder, labelled vanadinite on sandstone; from near Shrewsbury, Shropshire, bequeathed by Miss Caroline Birley. (B.M. 1907,912.) This material no doubt came from the same locality as Mr. Russell's specimens.

XI. Thin black, botryoidal, iridescent crust, yielding a yellow powder, on massive cerussite and pyromorphite with galena, &c.; from Leadhills, Lanarkshire. (B.M. 51280.) This specimen was presented and described by T. Davies [10] as vauquelinite. Mr. W. Campbell Smith in 1922 detected the presence of vanadium and water, and Mr. Hey in 1929 detected lead, copper, and vanadium, but no chromium or zinc.

XII. Thin black crust, yielding a canary-yellow powder, with vanadinite on massive pyromorphite, from Wanlockhead, Dumfriesshire. (B.M. 51281.) This

[1] C. Bergemann, Ann. Phys. Chem. (Poggendorff), 1850, vol. 80, p. 393.
[2] G. J. Brush, Amer. Journ. Sci., 1857, ser. 2, vol. 24, p. 116.
[3] F. Pisani, Bull. Soc. Franç. Min., 1889, vol. 12, p. 40.
[4] F. von Kobell, Journ. Prakt. Chem. (Erdmann), 1850, vol. 50, p. 496.
[5] C. Bergemann, Neues Jahrb. Min., 1857, p. 397.
[6] F. A. Genth, Proc. Amer. Phil. Soc., 1876, vol. 14 (for 1874–75), p. 229.
[7] F. A. Genth, Amer. Journ. Sci., 1876, ser. 3, vol. 12, p. 35.
[8] R. C. Wells, Amer. Journ. Sci., 1913, ser. 4, vol. 36, p. 636.
[9] S. Taber and W. T. Schaller, Amer. Min., 1930, vol. 15, p. 578. [M.A. 5-46.]
[10] T. Davies, Min. Mag., 1877, vol. 1, p. 112.

specimen was also presented by T. Davies, who labelled it vauquelinite. Mr. W. Campbell Smith in 1922 labelled the black mineral psittacinite, and Mr. Hey in 1929 detected lead, copper, and vanadium, but no chromium or phosphate. Frenzel [1] analysed the small brown spherules of 'vanadinite' on similar specimens from the same locality and concluded they were descloizite.

XIII. Yellow, powdery substance, coated brown on a heavy, brown, compact matrix; labelled chileite, from Mina Grande, near Arqueros, Chile. (B.M. 39332.) This material is probably the same as that described and analysed by I. Domeyko [2] in 1848.

XIV. Yellow, compact, botryoidal crusts, being one of the original specimens of eusynchite described by H. Fischer and Nessler in 1854,[3] from Hofsgrund, near Freiburg, Baden. (BM. 26942.) Their analyses showed it to be a lead vanadate, but a zinc content was discovered by subsequent workers, and I. Lang [4] carried out analyses and concluded that eusynchite is identical with descloizite.

XV. Deep brown-red descloizite crystals, with calcite and pyrolusite, from Sierra Grande mine, Lake Valley, Sierra Co., New Mexico. (B.M. 56878.) They are similar to crystals from the same locality described and analysed by F. A. Genth.[5] This is the only specimen listed here which yields crystals sufficiently small and perfect to be oriented by goniometric methods for X-ray photographs.

X-ray photographs of powdered material from each of the above specimens are identical (with the possible exception of chileite, no. XIII, which is probably mixed with impurities), and measurements show that there is no appreciable variation in unit-cell dimensions from one specimen to another. With the exception of specimens of compact material it is found that grinding the powdered crystals for a long time fails to reduce the grain sufficiently for powder photographs. In order to obtain an X-ray powder photograph quite free from flecks it is necessary to rotate the powder. Providing the specimen is very carefully centred in the X-ray beam no diminution in sharpness of the lines on the photograph results, and comparison of intensities is then possible.

Rotation, oscillation, and Laue photographs were also taken of a single crystal of descloizite specimen XV. The crystal used for these photographs shows the forms $m(110)$ and $o(111)$ [Dana's axes]. Goniometric measurements yield the axial ratios $a : b : c = 0{\cdot}645 : 1 : 0{\cdot}808$, in good agreement with vom Rath's values ($0{\cdot}6368 : 1 : 0{\cdot}8045$) for descloizite from the same locality and with A. Diefenbach's [6] values ($0{\cdot}6448 : 1 : 0{\cdot}8022$) for descloizite from South-West

[1] A. Frenzel, Neues Jahrb. Min., 1875, p. 673.
[2] I. Domeyko, Annales des Mines, Paris, 1848, ser. 4, vol. 14, p. 145.
[3] H. Fischer and Nessler, Ber. Verh. nat. Gesell. Freiburg, 1854, vol. 1, p. 33.
[4] I. Lang, Mitt. Badischen Geol. Landesanstalt, Heidelberg, 1903, vol. 4, p. 510.
[5] F. A. Genth and G. vom Rath, Zeits. Kryst. Min., 1885, vol. 10, p. 464.
[6] A. Diefenbach, Zeits. Krist., 1930, vol. 74, p. 178. [M.A. 4–382.]

Africa. Rotation photographs show that the edge of the orthorhombic unit cell are a 6·05, b 9·39, c 7·56 ± 0·03 Å. These values yield the axial ratios 0·644 : 1 : 0·805. Knowing the unit-cell dimensions it was possible to index correctly the powder photographs of I to XIV. Moreover, the diameters of the diffraction rings agree well with those calculated from the spacings for the single crystal. So far, then, identical X-ray photographs have been obtained not only for descloizites from different localities, but also for other minerals of the descloizite group. Table I gives the measurements of an X-ray powder photograph of no. IV.

TABLE I. Measurements of an X-ray powder photograph of specimen IV, mottramite from Nageib, South-West Africa.

Diameter of rings, cm. Observed.	Calculated.	Index.	Intensity.	Diameter of rings, cm. Observed.	Calculated.	Index.	Intensity.
1·85	1·87	(110)	*m*	3·50	3·503	(211)	*m*
2·00	1·99	(020)	*w*	3·57	3·56	(122)	*m*
2·20	2·215	(111)	*w*	3·65	3·62	(131)	*ms*
2·38	2·345	(021)	*w*	3·73	3·71	(220)	*w*
2·64	2·675	(012)	*w*	3·85	3·89	(013)	*vw*
2·90	2·93	(102)	*s*	3·93	3·925	(221)	*vw*
3·11	3·105	(200)	*vw*	4·12	4·14	(212)	*s*
3·30	3·255	(031)	*m*	4·56	4·55	(231)	*ms*

Diameter of cylindrical camera = 6·04 cm. Cu−K_α radiation with nickel filter was used, $\lambda = 1{\cdot}539$ Å. The calculated diameters of the diffraction rings are based on the unit-cell dimensions found for the single crystal of descloizite (no. XV) a 6·05, b 9·39, c 7·56 ± 0·03 Å. s = strong, m = medium, w = weak, vw = very weak.

Thin sections of crystals from specimens I, II, and III were prepared to see whether any marked zoning is present. Zoning is most marked in specimens I and III, but could not be detected in II. Green crystals from III form distorted, branched, and parallel growths, and only the interior is brown and translucent. The exterior is quite compact, and at first suggested that the green coating might be pseudomorphous. The X-ray and chemical work disprove this, however, and it is more probable that the difference in colour and texture is due to a physical change. Three sections were cut from crystals of specimen I parallel to the faces a(100), and b(010), and c(001) respectively. The section showing the greatest zoning is that parallel to c(001) and perpendicular to the acute bisectrix, the optic axial plane being parallel to b(010). No reliable value of 2E could be obtained, however, since 2V is near 90°. Birefringence measurements

were also rendered difficult because of the deep colour of the mineral and the high birefringence. Approximate refractive index measurements were carried out using fragments of various specimens in sulphur-selenium melts. The mean refractive indices of mottramite and descloizite do not differ by more than 0·05; $n_\alpha = 2{\cdot}21$, $n_\gamma = 2{\cdot}33 \pm 0{\cdot}02$. The birefringences measured by Mr. Hey on the three sections of specimen I are $\gamma - \alpha = 0{\cdot}12 \pm 0{\cdot}04$ on $b(010)$, $0{\cdot}07 \pm 0{\cdot}02$ on $a(100)$, and $0{\cdot}06 \pm 0{\cdot}02$ on $c(001)$. These measurements do not permit a decision as to which is $\beta - \alpha$ and which is $\gamma - \beta$. Sections of specimens II and III not cut in any known direction give values near 0·12. All the sections are highly pleochroic: for specimen I, γ brown-yellow, α and β canary-yellow; and for specimen III, γ brown-yellow, α and β green-yellow.

Table II gives the results of Mr. Hey's chemical analyses of specimens I to VI, together with density determinations. It is difficult

Table II. Chemical analyses of descloizite and mottramite. Specimens I–VI. (By M. H. Hey.)

	I.	II.	III.	IV.	V.	VI.
V_2O_5	22·76	22·73	22·73	22·65	17·66	16·26
As_2O_5	nil	nil	nil	nil	nil	7·13
PbO	55·47	55·78	54·56	54·50	44·50	54·10
CuO	0·56	10·29	16·84	13·90	15·70	0·61
ZnO	19·21	8·86	2·62	5·12	0·57	19·46
FeO*	trace	0·72	0·58	0·53	1·95	trace
MnO	trace	0·01	trace	trace	trace	trace
$H_2O + 350°$ C.... ...	2·17	2·24	2·29	2·09	1·80	2·29
$H_2O - 350°$ C.... ...	0·02	0·12	0·40	0·58	1·08	0·08
SiO_2	0·02	0·11	nil	0·89	16·31	0·27
Total	100·21	100·86	100·02	100·26	99·57	100·20
Oxygen %	17·84	17·82	18·01	18·01	17·75	17·43
Density (obs.) ...	6·26	6·18	5·80	5·96	5·5†	6·24
Density (calc.) ...	6·20	6·21	6·14	6·14	6·23	6·35

NiO, CoO, and P_2O_5 were tested for in nos. I, II, III, IV, and VI and found absent. Weights of material used for analyses V and VI about 0·6 gram; for the other analyses larger amounts were available.

* Total Fe estimated as FeO. In analysis V a part of or perhaps all the iron is present as Fe_2O_3 in the sandstone.

† Corrected for admixed sandstone, but still $\pm 0{\cdot}5$.

to obtain satisfactory densities of many of these specimens, either because of insufficient material or the fibrous structure of the botryoidal specimens. For this reason densities calculated from the X-ray data are tabulated rather than the number of oxygen atoms per

unit cell. The most reliable density figure was obtained for no. II, the material of which is uniform and free from zoning. Using this figure, the unit-cell dimensions, and the oxygen percentage given by chemical analysis, the number of oxygen atoms per unit cell is calculated to be 17·94 excluding the water content.

The number of vanadium, lead, copper, zinc, &c., atoms per unit cell have been calculated assuming 18 oxygen atoms per unit cell, excluding the water content, for all six analyses. It can be seen from table III that both the lead and vanadium contents are constant at

Table III. Number of atoms per unit cell.
(Calculated from Table II.)

	I.	II.	III.	IV.	V.	VI.
V	4·03	4·01	4·01	4·03	3·81	3·97†
Pb	4·00	4·01	3·92	3·95	3·92	4·00
Cu	0·11	2·07	3·40	2·83	3·88	0·13
Zn	3·80	1·75	0·52	1·02	0·14	3·94
Fe	trace	0·16	0·13	0·12	0·53	trace
Mn	trace	0·02	trace	trace	trace	trace
ΣZn*	3·91	3·98	4·05	3·97	4·55	4·07
H_2O+	1·94	2·00	2·03	1·87	1·96	2·09
H_2O-	0·02	0·11	0·36	0·52	1·19	0·07

* $\Sigma Zn = Zn + Cu + Mn + Fe$.
† Including 1·02 atoms As.

four atoms per unit cell, while the sum of the zinc, copper, iron, and manganese atoms also amounts to four. All previous analyses of the descloizite minerals have been recalculated in the same way to give the number of atoms of each sort in the unit cell. For all analyses in which an accurate separation of zinc from vanadium has been effected the atomic contents show the same relations as Mr. Hey's analyses. Phosphorus and arsenic can replace vanadium up to 0·4 and 1·0 atoms per unit cell respectively, the highest phosphorus and arsenic contents being usually found in botryoidal fibrous forms rather than in well-crystallized specimens. The content of manganese and iron rarely exceeds 0·2 atoms per cell. All the available analyses show that the zinc and copper content can have values ranging from 0 to 4, providing the sum $Zn + Cu + Fe + Mn = 4$. This suggests a complete isomorphous series between the zinc-rich and the copper-rich descloizites. Taber and Schaller (loc. cit.) have questioned the isomorphism of these two end-members, pointing out that copper-rich descloizite has a higher water content corresponding approximately to twice that found for copper-poor descloizite. Both

Pufahl[1] and Diefenbach[2] have obtained the same results, though they attribute the extra molecule of water to adsorption, and do not consider it to be water of constitution. This appears to be the correct conclusion for many reasons.

W. F. Hillebrand[3] determined the water content of a dull-yellow friable specimen of compact descloizite from Mayflower mine, Beaverhead Co., Montana, containing only 1·15 % CuO, i.e. 0·25 atoms of Cu per unit cell. He found for material dried at 100° C. that the water lost on heating to a dull red-heat was 4·37 %, which, recalculated, is equivalent to 4·12 H_2O per unit cell. I. Lang[4] also found 3 % of H_2O in a specimen of eusynchite from the type locality, but did not record any copper content. These specimens differ from ordinary descloizite in being either fibrous as in eusynchite or compact. Such finely crystalline or powdery material is more often rich in copper; the excess water content is not a direct consequence of high copper content, but is connected with the state of subdivision of the specimen and its previous history.

Although most analysts have recorded the fact that descloizites give up their water content only on heating to a red-heat no data are recorded giving the loss of water at various temperatures. Mr. Hey, employing the method of Dittler and Hueber, determined the amount of water lost at 110°, 200°, 350° C., and a dull red-heat for specimens II, III, IV, and V. He also confirmed the total water contents given in table II by the Penfield method. The results are shown in table IV.

Table IV. Dehydration data for descloizite and mottramite.
(By M. H. Hey.)

Total loss at:	Loss of water (%). II.	III.	IV.	V.
110° C.	nil	0·09	0·39	0·38
200° C.	nil	0·26	0·39	0·62
350° C.	0·12	0·40	0·58	1·08
Red-heat	2·36	2·69	2·67	2·88
Total loss at:	**Loss of water (molecules). II.**	**III.**	**IV.**	**V.**
110° C.	nil	0·08	0·35	0·41
200° C.	nil	0·24	0·35	0·68
350° C.	0·11	0·36	0·52	1·19
Red-heat	2·11	2·39	2·39	3·17

[1] O. Pufahl, Centralblatt Min., 1920, p. 289. [M.A. **1**–150.]
[2] A. Diefenbach, loc. cit., p. 155. [M.A. **4**–382.]
[3] W. F. Hillebrand, Bull. U.S. Geol. Survey, 1890, no. 60, p. 130.
[4] I. Lang, Mitt. Badischen Geol. Landesanstalt, Heidelberg, 1903, vol. 4, p. 504.

It is evident from the data in table IV that the water of constitution, present as hydroxyl groups in the crystal-structure, is constant at $2H_2O$ per unit cell. The figure for the water given off below 350° C. does not approach any round number and it is greater for those specimens which are cryptocrystalline, viz. III, IV, and V. We hoped that one of the six specimens analysed would show a total figure for the loss of water approaching those found by Diefenbach for mottramite from South-West Africa and those given by Taber and Schaller for so-called psittacinite from Bisbee, Arizona.

Table V shows the total water content shown in recent analyses of mottramite from various localities. The suggestion that variable amounts of water may be absorbed and held up to temperatures of 350° C. is the most reasonable explanation of the facts.

TABLE V. Total water content of mottramite from recent analyses.

Locality.	H_2O %.	No. of H_2O mols. per unit cell.	Cu %.	Density.	Analyst.
S.-W. Africa	4·79	4·15	22·08	6·033	Diefenbach, 1930
,, ...	4·38	3·88	20·76	6·107	,,
,, ...	4·31	3·82	19·89	6·121	,,
,, ...	3·92	3·63	19·50	5·900	Pufahl, 1920
,, ...	3·93	3·61	18·75	5·930	,,
Bolivia ...	2·71	2·49	17·72	6·416	Dittler and Hueber, 1931 [1]
Arizona ...	4·79	4·58	19·10	—	Taber and Schaller, 1930
,, ...	3·63	3·39	17·04	—	Wells, 1913 [2]
S.-W. Africa	2·69	2·39	16·84	5·800	Hey, III
,, ...	2·67	2·39	13·90	5·960	,, IV
Harmer Hill	2·88	3·15	15·70	5·5	,, V

It is also important to note that powder photographs of specimens III and IV after being heated for many hours at 350° C. are identical with photographs taken before dehydration. It is only the water which is given off at a red-heat that is actually in combination. One further piece of evidence is offered by the X-ray work, and for that reason the description of the space-group determination has been delayed till now.

Oscillation photographs of the single crystal already used for rotation photographs were taken about the *b* and *c* axes and when these

[1] E. Dittler and H. Hueber, Min. Petr. Mitt. (Tschermak), 1931, vol. 41, p. 173. [M.A. 4–525.]

[2] R. C. Wells, Amer. Journ. Sci., 1913, ser. 4, vol. 36, p. 637.

were indexed, reflections of the type $(hk0)$ for $(h+k)$ odd and $(h0l)$ for l odd were found to be absent. The space-group is therefore V_h^{16}, which permits only fourfold and eightfold positions in the structure of descloizite. Thus the total number of oxygen atoms per unit cell should be a multiple of four or eight. The work already described shows that this number is approximately twenty. The unit cell would contain 22 oxygen atoms if an extra two molecules of water were included. This possibility is therefore prohibited for descloizite by the space-group determination.

Unfortunately, it has not been possible to isolate a single crystal of mottramite and perform a space-group determination. It may be said, however, that the evidence of the X-ray powder photographs and the chemical work make it almost certain that the water content of mottramite is the same as that of descloizite, and that the higher figures shown by some analyses are due to the cryptocrystalline state of the specimens examined.

The contents of the unit cell of any member of the descloizite group may now be written down from table III as $4PbO.4(Zn,Cu)O.2V_2O_5.2H_2O$; this is equivalent to $4Pb(Zn,Cu)(OH)(VO_4)$. It is probable that the (VO_4) and (OH) units each occupy a fourfold position in the crystal-structure. The constancy of the lead content in descloizite analyses suggests that the lead atoms also occupy a fourfold position, the zinc and copper atoms occupying yet another. The general constitutional formula for descloizite may therefore be written $Pb(Zn,Cu,Mn,Fe)(OH)[(V,As,P)O_4]$.

In the light of X-ray and chemical work there appears to be no case for retaining the three mineral names cuprodescloizite, mottramite, and psittacinite as separate species. It is, however, usual to retain a name for each end of an isomorphous series. The decision in this case rests upon priority. Both mottramite and psittacinite were named in 1876 (see p. 377), actually the latter a month later than mottramite. Cuprodescloizite was the name given by Rammelsberg[1] in 1883 to a mineral containing 8 % CuO and is therefore unsuitable. The only other rival is chileite, which was named by Kenngott[2] in 1853 on the evidence of Domeyko's analyses (1848). Since the name had already been employed by Breithaupt in 1840 for a mineral from Chile, afterwards found to be goethite, and

[1] C. Rammelsberg, Sitzungsber. Preuss. Akad. Wiss. Berlin, 1883, part 2, p. 1215.

[2] A. Kenngott, Mohs'sche Mineralsystem, Wien, 1853, p. 28.

Domeyko's analyses show an appreciable arsenic content, it would be confusing to retain this name for the copper-rich members of the descloizite group. Mottramite is the most suitable choice on all grounds. The use of the name psittacinite should be discontinued. Descloizite, of course, should be retained for the zinc end of the series. Since there is a complete isomorphous series between descloizite and mottramite, the latter name should be used for those members carrying more than 2 atoms of copper per unit cell, i.e. more than 10 % CuO. From Mr. Hey's analyses, III, IV, and V are therefore mottramites, I and VI descloizites, and II on the border-line. Of the remaining specimens identified by X-ray methods alone previous analyses of similar material show that all are mottramites except nos. XIV and XV.

Summary.—Oscillation, Laue, and rotation photographs show that descloizite has an orthorhombic unit cell with edges a 6·05, b 9·39, c 7·56 Å., and space group V_h^{16}. The unit cell contains $4PbZn(OH)(VO_4)$. Powder photographs of descloizite, cuprodescloizite, mottramite, psittacinite, chileite, eusynchite, and dechenite, from the type localities are identical with each other. New chemical analyses and determinations of the water content at various temperatures, together with the X-ray work, show that all these minerals may be represented by the general formula $Pb(Cu,Zn)(OH)(VO_4)$. Thin incrustations of minute black crystals on sandstone from Harmer Hill, near Shrewsbury, are identical with the original mottramite from Mottram St. Andrew, Cheshire. Mottramite is retained as the most suitable name for all descloizites containing more than 10 % CuO.

Note on the chemical analyses. (*By M. H. Hey.*)

Since the vanadates present unusual problems in the attainment of accurate analyses, some description of the methods used appears desirable. The method used for the water determination also calls for some comment.

The principal difficulties encountered in vanadate analyses are the tendency of the basic sulphides of group II (especially CuS and PbS) to carry down the corresponding sulphovanadates in appreciable amount, and the tendency of the ammonia precipitate to carry down vanadium by adsorption.[1] A survey of earlier analyses suggests that the first of these sources of error has often been neglected. The difficulty of obtaining complete precipitation of vanadium is best overcome by the use of volumetric methods.

[1] See for example W. F. Hillebrand and G. E. F. Lundell, Applied inorganic analyses, New York, 1929, pp. 352–363. The present method as a whole is, so far as I am aware, new, but is based on the statements and suggestions made in Dr. Hillebrand's admirable account.

The partial precipitation of vanadium in group II was avoided by addition of tartaric acid in amount sufficient to prevent ammonia producing any precipitate. The precipitate so obtained might contain CuS, PbS, As_2S_5, and some ZnS; it was dissolved and the lead removed as sulphate, then copper and zinc precipitated with H_2S in ammoniacal solution and the filtrate examined for arsenic. The copper and zinc sulphides were dissolved, the copper precipitated as cuprous thiocyanate, and the zinc solution reserved.

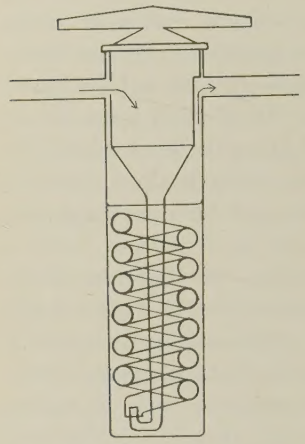

Fig. 1. Wash-bottle for determination of water content by Dittler and Hueber's method. (Half actual size.)

The filtrate from group II was made ammoniacal and treated with H_2S, precipitating Fe, Zn, Mn, and any Ni and Co, as sulphides. These metals were thus obtained free from tartaric acid, vanadium, and phosphorus, and were separated in the usual way.

Preliminary tests had shown that Ca and Mg were absent, and the alkalis were neglected. The filtrate from the ammonium sulphide group, therefore, had only to be examined for vanadium and phosphorus. It was evaporated down, and the tartaric acid destroyed with sulphuric and nitric acids, and finally $KMnO_4$ added in slight excess; the solution was then reduced with SO_2 and the vanadium estimated volumetrically. For each analysis the solution was reduced and titrated twice; then the vanadium was reduced again and phosphorus tested for with ammonium molybdate. The results of this procedure were highly satisfactory.

For the estimation of the water, the method of J. Lindner, as modified by E. Dittler and H. Hueber,[1] was employed, and found satisfactory. The only modification made in Dittler and Hueber's apparatus was that the special wash-bottle illustrated by them was replaced by a simpler model, the flat glass spiral, ground in, being replaced by a spiral glass tube. It is somewhat similar to the well-known Walter's pattern, but more compact, and is shut off from the atmosphere by turning the stopper (fig. 1). This pattern of wash-bottle was used both for the α-naphthyl phosphoric chloride and for the alkali. With a bubble rate of 2–3 per second it gives complete reaction or absorption with a single passage.

The somewhat inaccessible reagent employed by Lindner and by Dittler and Hueber, α-naphthyl dichlorphosphine oxide, $C_{10}H_7.POCl_2$, was replaced by α-naphthyl phosphoric chloride, $C_{10}H_7O.POCl_2$, which is readily prepared from α-naphthol and phosphorus oxychloride,[2] and which was found to fulfil the requirements of non-volatility, stability, and quantitative reaction with water perfectly. Preliminary tests showed it to be a quite satisfactory substitute.

[1] E. Dittler and H. Hueber, Zeits. Anorg. Chem., 1930, vol. 195, p. 41; 1931, vol. 199, p. 17. [M.A. 5–141.]

[2] See P. Kunz, Ber. Deut. Chem. Gesell., 1894, vol. 27, part 2, p. 2561.